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Membership is open to anyone interested in its aims: conservation of all native plants; education of the public to appreciate and preserve plant life; sponsorship of research and publication on the plant life of the State and the Great Lakes area in general, both in the USA and in Canada; sponsorship of legislation to promote the preservation of Michigan's native flora; establishment of suitable sanctuaries and natural areas, and cooperation in programs concerned with the wise use and conservation of all natural resources and scenic features.

Dues are modest, but vary slightly among the chapters. "Chapters members" should contact the chapter presidents listed below. "Special Members" (not affiliated with a chapter) may send US$17 to Alta Lahner, Special Membership Chair, 6088 Old Log Trail, Kalamazoo, MI 49009-9167; belaalta@aol.com. For both classes of membership, annual dues include a subscription to The Michigan Botanist. Address changes for Chapter Members should go to the Chapter President; address changes for Special Members should go to Alta Lahner.

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DISTRIBUTIONAL NOTES FOR THE FLORA OF WISCONSIN

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The flora of Wisconsin is very well studied, and documentation available on the plant species found in the state is extensive (Judziewicz 2003; Wisconsin State Herbarium 2003). Wetter et al. (2001) stated that 3243 vascular plant species were known for Wisconsin, 2366 of which are native. Distributional maps are provided for many of the state's plant species on the Wisconsin vascular plant species web site (Wisconsin State Herbarium 2003) and in Cochrane & Iltis (2000), as well as at the University of Wisconsin Stevens Point web site (Judziewicz 2003). Two other Wisconsin county records were recently reported in a paper on the flora of the Chicago region (Lammers 2003): *Carex muskingumensis* Schwein. (Cyperaceae) and *Samolus parviflorus* Raf. (Primulaceae).

Species given below as state records for Wisconsin are not listed in any of the following sources as occurring in the state: Cochrane and Iltis (2000), Gleason and Cronquist (1991), Judziewicz (2003), USDA (2002), Wetter et al. (2001), Wisconsin State Herbarium (2003), or in the appropriate volume of the Flora of North America, if published. Six species are designated as state records in this note. New county record designation is given if the species was not mapped for a particular county on the Wisconsin State Herbarium (2003) web site or the University of Wisconsin Stevens Point web site (Judziewicz 2003). New county records are given for 17 species. An additional species, *Cymbalaria muralis*, is listed as a recent collection of a species excluded by Wisconsin State Herbarium (2003) from the state flora.

Several species included in the list are greenhouse weeds. These are as follow: *Cardamine flexuosa, Cymbalaria muralis, Fatoua villosa, Gypsophila muralis, Parietaria floridana*. Two of these, *Cardamine flexuosa* and *Gypsophila muralis* are also represented by collections from outdoor populations, and are likely established or on their way to becoming established in the flora. Of the remainder, *Fatoua villosa* is also likely to become established in the state; it is known from many sites throughout North America (Wunderlin 1997), and was recently reported from Michigan by Reznicek (2001). The rest are included as

novelties, though they may or may not spread from the greenhouse settings in which they were found. Greenhouses and other horticultural settings often serve as conduits through which weedy species are spread.

Beckmannia syzigachne (Steud.) Fern. American slough grass (Poaceae; county record)

WISCONSIN: Waushara Co.: Aurora Twp. T18N R13E S8 SW¼, at jct. of State Hwy 21 and State Hwy 49, 1 mi SE of Auroraville, abundant in wet open roadside ditch, 17 Jul 2003, *T. G. Lammers 11625 & N. A. Harriman* (ISC, MU, NY, OSH).

American slough grass is native to marshes and ditches throughout much of the western United States, east through Wisconsin to Michigan, Ohio, and New York (Hitchcock 1950). In Wisconsin, the species was previously reported from 15 counties scattered across the state (Wisconsin State Herbarium 2003).

Blephilia hirsuta (Pursh) Benth. Hairy wood mint (Lamiaceae; county record)

WISCONSIN: Brown Co., Holland Twp., Holland State Wildlife Area, 1 Aug 2002, *M. A. Vincent 10777, T. G. Lammers & N. A. Harriman* (MU); *ibid, T. G. Lammers 11558, M. A.Vincent & N. A. Harriman* (BHO, BRIT, OSH).

Hairy wood mint is reported for nine other counties in the state by Wisconsin State Herbarium (2003); this population represents the northeastern-most site discovered to date in Wisconsin.

Cardamine flexuosa With. Bending bitter cress (Brassicaceae; state record)

WISCONSIN: Dane Co., University of Wisconsin campus, Madison, weedy in flower beds, 5 Aug 2002, *M. A. Vincent 10820* (MU), common weed in Botany Department greenhouse, Birge Hall, 7 Aug 2002, *M. A. Vincent 10821* (MU, OSH); Dodge Co., Beaver Dam Twp., weedy on nursery grounds outside and in greenhouses, 3 Aug 2002, *M. A. Vincent 10819* (MU, OSH); Waushara Co., Wautoma, weedy on nursery grounds, 30 Jul 2003, *M. A. Vincent 10683, T. G. Lammers & N. A. Harriman* (MU, OSH); Winnebago Co., Oshkosh, weedy in gravel beds and pots outdoors in a nursery, 3 Aug 2002, *M. A. Vincent 10802 & T. G. Lammers* (MU, OSH), weedy in greenhouse, 3 Aug 2002, *M. A. Vincent 10804 & T. G. Lammers* (MU, OSH).

This introduced small bitter cress species was listed by Rollins (1993) as occurring only sporadically, but is much more widespread. It is being distributed rapidly across the continent through the horticultural industry (current research of the senior author).

Carex cumulata (L. H. Bailey) Mack. Clustered sedge (Cyperaceae; county record)

WISCONSIN: Waushara Co., Warren Twp., east edge of Redgranite, 30 Jul 2002, *M. A. Vincent 10759, T. G. Lammers & N. A. Harriman* (DOV, MU).

According to the distribution map given by Wisconsin State Herbarium (2003), this new record is the eastern-most in the state. The species is described as infrequent and seldom abundant by Mastrogiuseppe et al. (2002), though it is distributed widely in northeastern United States and adjacent Canada.

Chamaesyce hirta (L.) Millsp. (=*Euphorbia hirta* L.) Pillpod sandmat (Euphorbiaceae, state record)

WISCONSIN: Waushara Co., Wautoma, weedy on nursery grounds, 30 Jul 2003, *M. A. Vincent 10684, T. G. Lammers & N. A. Harriman* (MU, OSH).

This species is generally found in more southern areas, and is considered a tropical to subtropical species. It has been reported for Michigan (USDA 2002), and is known from stations in other states in the midwest (Vincent, unpublished).

Coronilla varia L. Crown-vetch (Fabaceae; county record)

WISCONSIN: Dodge Co., Beaver Dam, roadside weed, 3 Aug 2002, *M. A. Vincent 10814* (MU, OSH).

Coronilla varia is wide-spread in Wisconsin. The oldest record for it in WIS is 1946, according to the Wisconsin State Herbarium website, and therefore it is not mentioned in Fassett (1939). It is commonly used in seed mixes for road-side soil stabilization (Isely 1998). The species is becoming quite invasive in some areas, and is now considered a noxious weed in some states (e.g., Ohio, Gardner & Hillmer 2002). This collection documents a population in a new county in the east-central part of the state.

Cucurbita pepo L. Pumpkin (Cucurbitaceae; state record)

WISCONSIN: Dodge Co., Beaver Dam, roadside weed, 3 Aug 2002, *M. A. Vincent 10816* (MU, OSH).

The name *C. pepo* in restricted to pumpkin and allied cultivars, while *C. maxima* should be restricted to winter squashes, such as hubbard and acorn squash (USDA 2002, Whitaker and Davis 1962). Wisconsin State Herbarium (2003) records for *C. maxima* may be of both species, and should be further investigated.

Cymbalaria muralis Gaertn., G. Mey. & Scherb. Kennilworth ivy (Scrophulariaceae)

WISCONSIN: Winnebago Co., Oshkosh, weed in greenhouse, not cultivated, 3 Aug 2002, *M. A. Vincent 10806, T. G. Lammers & N. A. Harriman* (MU, OSH).

Kennilworth ivy is listed as excluded from the Wisconsin flora (Wisconsin State Herbarium 2003). This collection is of the species as a weed in a greenhouse, and may indicate that the species could be more widespread than records indicate. It is known as a weed from the adjacent states of Illinois and Michigan (USDA 2002).

Eupatorium altissimum L. Upland boneset (Asteraceae; county record)

WISCONSIN: Outagamie Co.: Dale Twp. T21N R15E section 27, along RR tracks southeast of Dale, between Industrial Dr. and Hunters Rd., rocky railway bed, 29 Aug 2003, *T. G. Lammers 11780 & N. A. Harriman* (OSH).

Eupatorium altissimum has previously been reported mostly from southern counties; this collection extends the northern limit of its range in Wisconsin.

Fatoua villosa (Thunb.) Nakai Mulberry-weed (Moraceae; state record)

WISCONSIN: Winnebago Co., Oshkosh, weedy in greenhouse, 3 Aug 2002, *M. A. Vincent 10805 & T. G. Lammers* (MU, OSH).

Mulberry-weed is spreading rapidly across North America through the horticultural industry (senior author's present research). It is likely to be found in outdoor settings in Wisconsin, especially since it is known from many sites throughout North America (Wunderlin 1997), and a population was recently reported from Michigan by Reznicek (2001).

Gaura biennis L. var. *biennis* Biennial bee-blossom (Onagraceae; county record)

WISCONSIN: Racine Co.: Caledonia Twp. T4N R22E section 3 N½ , along RR tracks north of the Root River bridge and 7½ Mile Rd., just S of the Milwaukee Co. line, brushy right-of-way, 27 Aug 1999, *T. G. Lammers 10813 & N. A. Harriman* (MU, OSH).

This species is widely distributed in eastern North America (USDA 2002). This collection is a new county for Wisconsin (Wisconsin State Herbarium 2003), and is also an addition to the flora of the Chicago region of Swink and Wilhelm (1994).

Gypsophila muralis L. Cushion baby's breath (Caryophyllaceae; county record)

WISCONSIN: Dodge Co., Beaver Dam Twp., weedy on nursery grounds outside and in greenhouses, 3 Aug 2002, *M. A. Vincent 10818* (MU, OSH).

Cushion baby's breath had previously been known from nine scattered counties in the state (Wisconsin State Herbarium 2003). The species is sometimes cultivated as a bedding plant and escapes readily, as was the case at this site.

Iris pseudacorus L. Yellow flag (Iridaceae; county record)

WISCONSIN: Manitowoc Co., along St. Rt. 42 6 miles north of St. Rt. 310, 10 Jun 1994, *M. A. Vincent 6505 & T. G. Lammers* (MU, OSH).

Yellow flag has previously been reported for 12 counties in Wisconsin (Wisconsin State Herbarium 2003). It has been widely introduced in North America and easily escapes into wet areas (Henderson 2002). In addition to the normal, yellow-flowered plants, a single white-flowered plant was found at this site (*M. A. Vincent 6506 & T. G. Lammers,* MU).

Lotus corniculatus L. Bird's-foot trefoil (Fabaceae; county record)

WISCONSIN: Dodge Co., Beaver Dam, roadside weed, 3 Aug 2002, *M. A. Vincent 10817* (MU, OSH).

Bird's-foot trefoil is a common weedy species in much of the United States (USDA 2002), where is has been used in roadside seeding mixes and as a forage crop (Isely 1998). It seems a relatively recent introduction to Wisconsin, and was not listed for the state by Fassett (1939); the oldest collection in WIS is 1958; it is now widespread (Wisconsin State Herbarium 2003).

Lycopodiella margueritae J. G. Bruce, W. H. Wagner & Beitel Northern prostrate club-moss (Lycopodiaceae; state record)

WISCONSIN: Wood Co., Cranmoor Twp., cranberry bog west of Nekoosa, 30 Jul 2002, *M.A. Vincent 10727, T.G. Lammers & N.A. Harriman* (MU).

This diminutive species is not listed for Wisconsin by the Wisconsin State Herbarium (2003). Wagner and Beitel (1993) list this species only for Michigan. It was reported for Ohio by Cooperrider et al. (2001). Identification of the specimen was confirmed by R.J. Hickey and A.W. Cusick.

Matricaria recutita L. Chamomile (Asteraceae; county record)

WISCONSIN: Fond du Lac Co., Lamartine Twp., weedy roadside, 3 Aug 2002, *M. A. Vincent 10812* (MU, OSH).

This is the common chamomile of "chamomile tea." It is a widespread species in North America, having been introduced from Europe (USDA 2002). In Wisconsin, the species has previously been known from 10 counties (Wisconsin State Herbarium 2003).

Odontites serotina (Lam.) Dumort. Odontites (Scrophulariaceae; county record)

WISCONSIN: Winnebago Co.: Winchester Twp. T20N R15E section 1 SE¼, along County Hwy M, 0.5 mi N of its jct. with North Loop Rd., in the Rat River State Wildlife Area, ca. 2.6 mi S of Medina, abundant on grassy roadside, 29 Aug 2003, *T. G. Lammers 11775 & N. A. Harriman* (BRIT, MO, MU, NY, OSH, WU).

Odontites was first reported for Wisconsin by Harriman (1970), and is now known from Brown, Door, Kewaunee, Manitowoc, Marinette, Oconto, Outagamie, and Shawano counties (Wisconsin State Herbarium 2003).

Parietaria floridana Nutt. Florida pellitory (Urticaceae; state record)

WISCONSIN: Winnebago Co., Oshkosh, weedy in greenhouse, 3 Aug 2002, *M.A. Vincent 10807 & T.G. Lammers* (MU, OSH).

Not listed for the state by Wisconsin State Herbarium (2003), this greenhouse weed is native to the Atlantic and Gulf coastal plains (Boufford 1997).

Platanthera obtusata (Banks ex Pursh) Lindl. Blunt bog orchid (Orchidaceae; county record)

WISCONSIN: Wood Co., Cranmoor Twp., cranberry bog west of Nekoosa, 30 Jul 2002, *M.A. Vincent 10730, T. G. Lammers & N. A. Harriman* (MU); *ibid, T. G. Lammers 11528, M. A. Vincent & N. A. Harriman* (NY, OSH).

Platanthera obtusata is a widespread species in Canada; in the United States, it is found only in the northernmost states, and further south in the Rocky Mountains (Sheviak 2002). This record represents a southwestern range extension for blunt bog orchid in Wisconsin. It should be noted that additional county records beyond those given by Wisconsin State Herbarium (2003) for the species are given by Case (1987), for Dunn, Shawano, and Taylor counties.

Polygonum careyi Olney Carey's smartweed (Polygonaceae; county record)

WISCONSIN: Waushara Co., Warren Twp., east edge of Redgranite, 30 Jul 2002, *M. A. Vincent 10752, T. G. Lammers & N.A. Harriman* (MU); *ibid, T. G. Lammers 11549, M. A. Vincent & N. A. Harriman* (NY, OSH).

Polygonum careyi is known from the northeastern quarter of the United States, and, interestingly, Florida (USDA 2002). In Wisconsin, it has previously been known from 13 counties (Wisconsin State Herbarium 2003).

Puccinellia distans (Jacq.) Parl. European alkali grass (Poaceae; county record)

WISCONSIN: Waushara Co.: Aurora Twp. T18N R13E S8 SW¼, at jct. of State Hwy 21 and State Hwy 49, 1 mi SE of Auroraville, wet open roadside ditch, 17 Jul 2003, *T.G.Lammers 11626 & N.A.Harriman* (ISC, MU, NY, OSH).

European alkali grass is found throughout the western US and in the northern half of the eastern part of the country (USDA 2002). It is found in widely scattered areas throughout eastern Wisconsin (Wisconsin State Herbarium 2003).

Silene cserei Baumg. Balkan catchfly (Caryophyllaceae; county record)

WISCONSIN: Waushara Co., Warren Twp., east edge of Redgranite, 30 Jul 2002, *M.A. Vincent 10755, T.G. Lammers & N.A. Harriman* (MU).

Balkan catchfly is found in many of the north-central and northeastern states in the US. It has been reported from many counties in the state (Wisconsin State Herbarium 2003).

Spergula arvensis L. Corn spurry (Caryophyllaceae; county record)

WISCONSIN: Wood Co., Cranmoor Twp., cranberry bog west of Nekoosa, 30 Jul 2002, *M.A. Vincent 10713, T.G. Lammers & N.A. Harriman* (MU).

Corn spurry is found as a weed in much of the United States (USDA 2002), and in widely scattered populations in Wisconsin (Wisconsin State Herbarium 2003).

Zizia aurea (L.) W.D.J.Koch Common golden alexanders (Apiaceae; county record)

WISCONSIN: Marinette Co., Marinette, along RR tracks parallelling US Hwy 41, 2.2 mi S of its jct. with County Hwy T, grassy open right-of-way, 10 Jun 1994, *M.A. Vincent 6547 & T.G. Lammers* (MU, OSH); *ibid*, *T.G. Lammers 9023 & M.A. Vincent* (F, UC).

This collection represents the northeasternmost county in the state for this widely distributed species (Wisconsin State Herbarium 2003).

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ANNOUNCEMENT

The Michigan Botanical Club 2005 Spring Foray, hosted by the Southeastern Chapter, will be held Friday, Saturday, Sunday, and Monday, 27–30 May 2005. We will be headquartered at the Holiday Inn of Troy and will have field trips into Oakland, Wayne, and Macomb Counties.

From the wetlands and woodlands of rolling Oakland County to the banks of the Detroit River to the bogs of the Thumb, there will be something for everyone here in Southeastern Michigan. Students interested in receiving the Joan Robb Student Scholarship Award to attend the Foray should contact the president of the chapter in the area where you live or attend school. The names and addresses of the Chapter Presidents are given on the inside front cover of the journal.

THE BIG TREES AND SHRUBS OF MICHIGAN
43. Magnolia ×soulangeana Soulange-Bodin
Saucer Magnolia

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The largest known Saucer Magnolia in Michigan is located in the village of Berrien Springs, in Berrien County, in the southwestern corner of Michigan's Lower Peninsula.

Description of the species: The Saucer Magnolia was created by a cross between *M. denudata* (the female; originally from China) and *M. liliiflora* (the male pollen producer; native to eastern China) by Etienne Soulange-Bodin, a former French diplomat and army officer, who later became director of the Royal Institute of Horticulture outside Paris in 1820 (Calloway, 1994). The plant was introduced into England in 1827 or 1828. It is intermediate in its features between the two parents. It is a large shrub or small tree (see Fig. 1) with alternate, simple, obovate to obovate-oblong leaves with narrowly acute to acuminate apices. The leaves are dark green and glabrous above, lighter in color and hairy below. The flower buds are very pubescent and silky to the touch. The bark is smooth and gray. The flowers are large, 3–6 inches (7–15 cm) across, white to red-purple on the outside and often fragrant. There are many variations and forms that run the gradient of flower color from almost white (cv 'alba') to deep red-purple (cv 'Alexandrina'). Both the parental species and their hybrid flower precociously—that is, they flower before the leaves emerge.

Spontaneous hybrids and backcrosses have occurred when different parents are grown in proximity. Over 40 registered cultivars have been named, making *M.* (*soulangeana* one of the most varied and popular magnolias in the world. An excellent discussion of variation in the Saucer Magnolia is found in Treseder (1978).

There is much variation in the range of chromosome numbers found in the hybrids. *Magnolia liliiflora* is a tetraploid (2n = 4x = 76) and *M. denudata* is a hexaploid (2n = 6x = 114). The resulting hybrid would possibly be an intermediate pentaploid (2n = 5x = 95). Incomplete pairing of the chromosomes in the hybrid might produce lower or higher numbers and many variations in between. Even though *M. ×soulangeana* hybrids are mostly seed sterile, a few seeds will occasionally develop in the aggregate of follicles.

Saucer Magnolia is one of the most cold-hardy of all magnolias—zones of plant hardiness, 4–9 (Dirr 1990)—and ideal for temperate climates, especially in Michigan. The tree never escapes from cultivation, at least in Michigan; it is mentioned in passing in Barnes and Wagner (1981; 2004). The specific epithet is

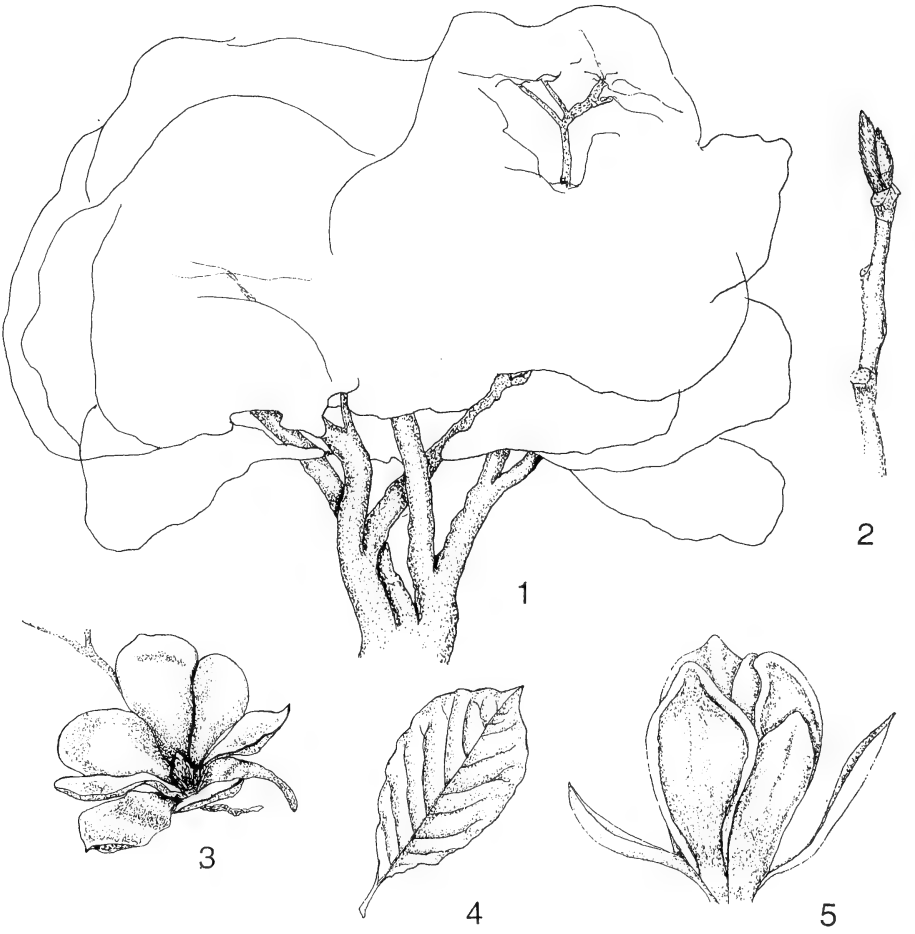

FIGURE 1. Characteristics of the Saucer Magnolia. Illustrations are by Lynn E. Steil. 1. Habit of mature champion tree showing overall form, 1% of lifesize; all the other drawings are 40% lifesize. 2. Twig with flower bud showing leaf scars with bundle scars. 3. Front view of flower. 4. Leaf and venation. 5. Opening flower in lateral view.

sometimes rendered as *soulangiana*, but the standard references, including Index Kewensis, have it as *soulangeana*.

Location of Michigan's Big Tree. The champion Saucer Magnolia is located one block NW of downtown in the village of Berrien Springs, Berrien County, behind 114 N. Kimmel Street and adjacent to nearby Mars Street at Lat. 41° 56′ 48″ N and Long. 86° 20′ 24″ W. The tree is out in the open on the northeast side of the home owned by Anna Stover and was planted in the 1920s by the grandmother of Mr. Stover. The specimen can be observed closely without going onto private property.

Description of Michigan's Big Tree: The tree has three healthy trunks arising

just above the ground at angles and with little dead wood. The circumferences of the tree's trunks at breast height were measured on 22 April 2002 at 41″, 50″, and 51″ (104, 127, and 130 cm), respectively. The diameter of each branch was 13.2″, 15.8″, and 16.2″ (34, 40, and 41 cm), respectively. The crown spread was 66′ (20.1 m). The height was measured at 38′ (11.6 m). This newly found champion replaces the previous one (41″, 1995) recorded from Ann Arbor, Washtenaw County. It is a spectacular, well-maintained specimen and worth a visit when in bloom in mid- to late April.

INVITATION TO PARTICIPATE

If you would like to join in extending this series of articles by visiting and describing one or more of Michigan's Big Trees, please contact Elwood B. Ehrle (woodyehrle@aol.com) for help with the locations , specifications for taking measurements, and assistance with the manuscript. The Michigan Botanical Club encourages your involvement in this activity. Please remember to ask permission before entering private property.

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ANNOUNCEMENT

Contributions from the University of Michigan Herbarium, volume 24, 7 February 2005, has just appeared. There is a fine paper by Edward G. Voss in this issue, one that will be of special interest to Michigan Botanist readers:

Voss, E. G. 2005. Gazeteer of some possibly puzzling collecting localities for Michigan plants. Contributions from the University of Michigan Herbarium 24: 189–225.

"Abstract. Listed alphabetically with county assignments are over 500 Michigan localities from which herbarium specimens have been seen but for which the labels lack county designations. Sites included usually (1) are not readily located in standard indexes to Michigan place names, (2) can be confused with other localities bearing the same names, and/or (3) have undergone a change in name. Documentation often cites published references, specific collectors, or dates."

Ordering information can be obtained at herbarium.lsa.umich.edu; the issue is $35 ($40 outside the USA), and the price includes shipping and handling.

THE ROLE OF FIRE IN GREAT LAKES ALVAR LANDSCAPES

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ABSTRACT

The role of fire in alvar landscapes in the Great Lakes region of the United States and Canada was examined through the notes of the original land surveyors, through field work which looked for burn evidence, and through a comparison of alvars on two sets of aerial photographs taken 40 to 45 years apart. The results show that alvars existed in all regions of the Great Lakes prior to settlement of the area by European immigrants. Also, fire can create alvars and has done so in the last 150 years. Some alvar community types correlate strongly with past burning while others correlate with no burning. Some community types show noticeable change in a 40 year period while others show little or none. Although the presence of burn evidence is common, fire is shown to be infrequent in alvar landscapes, with some communities experiencing fire return intervals of at least 200–500 years. In these communities, fire is not the primary factor maintaining the open condition. The history of Great Lakes alvars is shown to be diverse and complex. Controlled burning is not recommended for all sites or all alvar community types.

INTRODUCTION

"Alvar" is a Swedish word used for the grasslands on the island of Oland, in the Baltic Sea. The word is now commonly applied to natural, open, ecosystems which occur on shallow soils over flat limestone bedrock, and which have a dominant cover of grasses and sedges or low shrubs often with less than 25% cover of trees. The underlying bedrock may be exposed and appear as a natural "pavement" with plants growing from cracks or deep crevices. Most alvar ecosystems occur only around the Great Lakes in North America and in the Baltic region of Europe.

Alvar ecosystems are globally rare and contain many species and communities that are rare on a global or province/state-wide basis (Oldham 1999; Grossman et al. 1998; Bakowsky 1996). The different types of alvar (vegetation communities) in the Great Lakes region have recently been distinguished based on compositional and structural differences (Brownell and Riley 2000, Reschke et al. 1999; Lee et al. 1998; Bakowsky 1996).

Several recent studies have brought attention to the alvar ecosystems found around the Great Lakes (Brownell and Riley 2000; Reschke et al. 1999; Catling and Brownell 1998, 1999; Schaefer and Larson 1997; Gilman 1995; Belcher et

al. 1992; Belcher 1992). Despite the thoughtful design of these works, assumptions have still been made about the history and origin of Great Lakes alvars, because, for the most part, these topics have not been studied. Specifically, because evidence of burning is found on many alvars, many people assume all alvars need fire to remain in an open state (Brownell and Riley 2000; Catling and Brownell 1998).

The fact that alvars are open in a region where most of the natural landscape is forested has led to a number of hypotheses on how alvars originate and remain open. Drought, a seasonal cycle of drought and flooding, and fire have all been proposed as factors maintaining open conditions. The shallow soils charactieristic of alvars (usually <10 cm in the Great Lakes region) limit water holding capacity, and the nearly level, exposed bedrock limits drainage, leaving alvars often in conditions of either extreme saturation or drought. Stephenson and Herendeen (1986) studied patterns of drought on Drummond Island, Michigan alvars and found that drought was keeping trembling aspen (*Populus tremuloides* Michx.) from getting established in alvar grasslands. Reschke (1995) studied soil moisture regimes and evidence of fire at Chaumont Barrens in New York. She found that a seasonal cycle of summer drought and fall-spring saturation (or flooding) was strongly correlated with presence of alvar shrubland vegetation, but not with alvar grasslands. Catling and Brownell (1998) claim that the majority of alvars have burned and suggest that burning may have resulted in higher species diversity at the Burnt Lands Alvar in eastern Ontario. On the other hand, Schaefer and Larson (1997) found no difference in alvar community structure between alvars burned 70 years ago and those apparently never exposed to fire.

Many alvars do in fact show extensive evidence of burning; however, other alvars very similar to the burned ones present no burn evidence at all (data below). Speculation about alvar fire history leads to assumptions about the usefulness of fire as a management tool for alvars, but prior to this study no examination had been made of whether most alvar sites and community types had in fact burned in the past. This paper focuses on the history of Great Lakes alvars and attempts to clarify the role of fire in different alvar community types. For this work, the history of Great Lakes alvars was examined in a number of ways to investigate three main questions:

1) Did Great Lakes alvars exist before the time of settlement by European immigrants or were they opened up as a result of recent human disturbance?
2) To what extent is fire involved in the origin and maintenance of Great Lakes alvars, and do different alvar community types have different fire origins?
3) Do Great Lakes alvars remain always open or do they grow in to some extent over an observable period of time?

Vegetation history is difficult to examine directly, so an indirect approach of looking for correlations and empirical evidence is typically used (for example, Cronon 1983; Russell 1993). In this study, vegetation history is interpreted from

correlations among vegetation composition, evidence of fire, and historical vegetation patterns.

METHODS

To address the first question regarding the history of alvar vegetation, notes from the original land survey records were used to reconstruct the presettlement vegetation of extant alvar areas on the Bruce Peninsula, Carden Plain, and Manitoulin Island in Ontario, and in Jefferson County, New York. Similar work by Comer et al. (1995) for Drummond Island, Michigan and by Goodban (1995) for the Flamborough Plain, Ontario was also consulted. The original land surveys (Table 1) were done about 150 years ago to lay out the location of lots and roads so homesteaders could acquire land. The surveyors also wrote down characteristics of the land to help homesteaders choose property they had never seen and recognize it upon arrival. In this study, surveyors' comments such as "prairie," "plains," "rocky barrens," etc. were used to map the possible presence of alvars at the date of the survey.

In addition, we consulted old newspaper clippings and 15 elderly local residents, ages 74–96 in 1996, who had lived adjacent to alvar areas since childhood, to look for any obvious events (fire, logging, etc.) that might have created the alvars and to try to establish dates for burns.

To address the second question regarding the role of fire, the presence or absence of burn evidence was recorded in the field at 258 observation points, distributed among 67 sites. Sites were selected to sample the largest, best-known, and least anthropogenically disturbed alvars in each region, and to represent as many different kinds of alvar vegetation as possible. Multiple observation points were recorded at many sites to sample different vegetation communities or variations within community types. Burn evidence recorded included presence of charcoal, burnt woody debris or stumps, and fire scars on trees. In addition, a scan was made at each observation point for eastern white cedar trees (*Thuja occidentalis* L.) that could be exceptionally old (Larson and Kelly 1991), and some of the trees located in this process were cored. Dating of cores was done by Claudia Schaefer, then at the Cliff Ecology Research Lab, University of Guelph, Ontario. Information from Schaefer and Larson (1997) on old trees from Bruce Peninsula, Ontario alvars was also incorporated. Finally, Timothy Lynham, a fire history expert from the Canadian Forest Service, Natural Resources Canada, Sault Ste. Marie, Ontario, was escorted to a few sites to provide insight on possible fire history scenarios for some alvars. Relationships between community type and presence or absence of burn evidence were tallied. Community types used here follow those described by Reschke et al. 1999.

TABLE 1. Location and date of first survey of some Great Lakes alvar study areas.

Area Name	Location	Survey Date	Citations
Jefferson County, New York	44° 01′N, 76° 00′W	1799	Gilman 1996 Brodhead 1799 a–d
Bruce Peninsula, Ontario		1855	C. Schaefer 1996a
St. Edmunds Township	45° 01′N, 81° 22′ W		
Carden Township, Ontario	44° 38′N, 79° 00′W	1858	C. Schaefer 1996b
Flamborough Plain, Ontario			
Beverly Township	43° 25′N, 80° 00′W	1797	Goodban 1995
Manitoulin Island, Ontario			
Dawson Township	45° 53′N, 83° 08′W	1879	Fitzgerald 1879a
Robinson Township	45° 51′N, 82° 52′W	1879	Fitzgerald 1879b; Patten 1908
Burpee Township	45° 47′N, 82° 38′W	1878	Abrey 1878
Gordon Township	45° 52′N, 82° 28′W	1871	Bray 1871
Tehkummah Township	45° 37′N, 82° 02′W	1870	Fitzgerald 1870
Drummond Island, Michigan	46° 00′N, 83° 40′W	1845	General Land Office 1890 Comer et al. 1995

TABLE 2. Flight lines of aerial photos used in a comparison of alvars over a 40-45 year period.

Site Name	Photo Date	Flight Line	Shot Number
Manitoulin Island, Ontario			
Belanger Bay	1990	4529	18-163
	1946	A9826	30
Evansville Shrubland	1990	4528	18-58
	1946	A9826	84
Foxy Prairie	1990	4530	19-250, 251
	1990	4529	20-16
	1945	A9806	52, 54
	1946	A9819	35
La Cloche 1A	1990	4533	19-167
	1945	A9806	54
Misery Bay	1990	4527	18-76, 78
	1946	A9839	17, 18
Quarry Bay	1990	4529	18-160
	1946	A9819	70
Silver Water Radio Towers	1990	4530	19-235
	1946	A9808	62
Tamarack Harbour	1990	4521	7-119
	1945	A9603	71
Taskerville/Portage Pt.	1990	4526	18-106, 108, 110
	1946	A9951	71, 73, 75
West of Lynn Point	1990	4529	18-155
	1946	A9806	95
	1946	A9819	79
Carden Plain, Ontario	1987	4429	05-188
Carden alvar #1	1945	A9191	01, 70
Carden alvar #2	1987	4428	05-154, 154
	1945	A9191	01, 70
Carden alvar #3A	1987	4427	05-11
	1945	A9190	138
Carden alvar #5c	1987	4427	14, 15
	1987	4428	158
	1945	A9191	05
South Cameron Ranch	1987	4425	03-98
	1945	A9190	60, 71
Bruce Peninsula, Ontario			
Bear's Rump Island	1978	4522	220-50, 51
	1938	A6089	75
Cabot Head	1978	4517	220-95, 96
	1938	A6114	20
Driftwood Cove	1978	4517	220-72, 73
	1938	A6114	01
Scugog Lake	1978	4508	220-127
	1978	4509	220-102
	1938	A6087	98
	1938	A6088	38
Sideroad Creek	1978	4513	219-82
	1938	A6088	82 s

TABLE 3. Changes looked for at documented observation points on aerial photos.

SIZE:	Little or no change in size of community
	Community was larger in the past
	Community was smaller in the past
VEGETATIVE COVER:	
	Little or no change in cover of community
	Community was sparser in the past
	Community was more vegetated in the past
DENSITY:	Little or no change in # of trees in community
	Community had fewer trees in the past
	Community had more trees in the past
ADJACENT WOODED AREAS :	
	Little or no change in adjacent wooded areas
	Adjacent wooded areas were more open in the past
	Adjacent wooded areas were denser in the past
ISLANDS AND LINES TREES :	
	Little or no change in islands or lines of trees
	Islands or lines of trees were smaller or sparser in the past
	Islands or lines of trees were larger or denser in the past

To address the third question regarding vegetation dynamics, a qualitative comparison of aerial photographs was made to evaluate changes in size, sparseness of vegetation, and number of trees present in some alvars over a period of 40–45 years. Comparing the oldest available aerial photos to the most recent ones (flight lines and dates listed in Table 2) of the Bruce Peninsula, Carden Plain, and Manitoulin Island, Ontario, alvar openings containing field-documented observation points were evaluated. A standard set of changes (Table 3) was looked for and the results sorted by community type. Community classification follows Reschke et al. 1999.

RESULTS

1) Review of Land Survey Records

Northern New York

Land survey records were available for 7 sites in Northern New York. Of these, a portion of one site was listed as "good for meadow," and portions of six other sites were described as "rocky," "rough," or "plenty of limestone," indicating the limestone substrate was exposed. All sites (except the "good for meadow" site) appear to have had trees present, including maple (*Acer* sp.), beech (*Fagus grandifolia*) and other hardwoods, and white pine (*Pinus strobus* L.).

Drummond Island, Michigan

Alvar was clearly identified at Maxton Plains in the survey of 1845 (General Land Office 1816–1856). Several parts were described as "naked rock with scattering of small trees growing in crevices" or a slight variation.

Flamborough Plain, Ontario

The surveyor's notes show the northern half of Beverly Township (an alvar location today) was covered with maple (*Acer* sp.), elm (*Ulmus* sp.) and basswood (*Tilia americana*), and most outcrop areas appear to have been well

wooded (Goodban, 1995). A few places corresponding to current alvar sites were described as "broken land" or having only small trees, and one area, immediately adjacent to the Hayesland Alvar, was listed as "meadow" (Goodban, 1995).

Carden Plain, Ontario

The survey of 1856 shows many patches of alvar ("plains," "prairie," "soil burnt off to rock," etc.) existed in what are now Carden Alvars 1, 2, 3, and 5. However, the patches appear to be smaller than today's alvars. A few historical patches are not alvar now, indicating the alvars either grew in with trees or have been altered by agricultural practices. One alvar, Carden Alvar 4, appears to have been entirely forested with cedar (*Thuja occidentalis* L.) and tamarack (*Larix laricina*).

Bruce Peninsula, Ontario

The survey notes of St. Edmund's Township show much alvar in 1855. Of 6 alvar sites for which information was available, at least a portion of 5 were "rocky and barren," "timber scrubby and soil rocky," or "moss covered rocks." The alvar at Hopkins Bay probably did not exist and was noted as forested with cedar and balsam (*Abies balsamea*).

Manitoulin Island, Ontario

Almost the entire Lake Huron shore from the middle of the island to the western tip and inland for 2–4 km, was described in various ways as "no soil," "barren flat rock," "burnt," or "stunted timber" in the surveys of 1878–79. This area includes 6 alvar study sites as well as several other current alvars. The area that was open in the past was much more extensive than the alvars of today, indicating that many areas have become reforested. North of the Lake Huron shore, two other alvar study sites had areas described as "grassy meadow," "barren land," etc. However, a further two alvar study sites were not open at all but were forested with "timber of mixed character and average size" or "thick growth of small cedar, balsam, tamarack." Thus, of 10 study sites for which information was available, 8 were open and two were forested.

A few alvars were clearly created by fire in the last 150 years. On Manitoulin Island, the Silver Water Radio Towers site (a shrubland alvar) was listed as "good level land with mixed timber" and "sandy loam or average depth and some large cedar" in the survey of 1879. Elderly local residents recalled an extensive fire at this site in 1925. In New York, an area of Limerick Cedars near Perch River, which was tree-covered in a 1948 aerial photo, burned in an intense fire in 1953. Newspaper photos locate the fire at what is now a fairly barren alvar dominated by non-vascular plants. Finally, Carden Alvar 4 and the Manitoulin Island alvar West of South Baymouth were forested in the first surveys. No detailed information on fire has yet been found for these sites, but both have burn evidence present.

Elderly Manitoulin Island residents did not recall frequent fires on any alvars in the Manitoulin Island study area. A few isolated, major fires such as the one already mentioned at Silver Water were remembered or well known from their parents or elders' stories, yet for the majority of the alvars, no fires at all were known to have occurred in the span of time known to the informants.

TABLE 4. Observation points in each alvar community type showing presence or absence of burn evidence. Community type classification follows Reschke et al. (1999).

Alvar Community Type	Total # of obs. pts.	# with burn evidence present	# with burn evidence absent	% with burn evidence present
Bur oak limestone savanna	n=9	9	0	100
White cedar -jack pine / shrubby cinquefoil alvar savanna	n=16	16	0	100
Mixed conifer / common juniper alvar woodland	n=6	5	1	83
Alvar non-vascular pavement	n=7	6	1	86
Creeping juniper—shrubby cinquefoil alvar shrubland	n=21	15	6	71
Juniper alvar shrubland	n=41	25	16	61
Poverty grass dry alvar grassland	n=11	6	5	54
Scrub conifer / dwarf lake iris alvar shrubland	n=7	3	4	43
Little bluestem alvar grassland	n=59	24	35	41
Tufted hairgrass wet alvar grassland	n=36	10	26	28
Red cedar / early buttercup alvar woodland	n=7	1	6	14
Annual alvar pavement—grassland	n=15	2	13	13

2) The Role of Fire in Different Alvar Community Types

Some alvar community types show a strong correlation with presence of burn evidence while others do not (Table 4).

There is a strong correlation with burning in Bur oak limestone savanna and White cedar-jack pine / shrubby cinquefoil alvar savanna, where all observation points have burn evidence present, and in Mixed conifer / common juniper alvar woodland with 83% presence. Alvar non-vascular pavement and Creeping juniper—shrubby cinquefoil alvar shrubland also show a high percentage of burn evidence presence (86 % and 71% of observation points respectively).

On the other hand, the somewhat mesic community types Tufted hairgrass wet alvar grassland and Annual alvar pavement—grassland show a correlation with lack of burn evidence. Red cedar / early buttercup alvar woodland observation points also show little burn evidence although the moisture regime here is unclear.

Other types show a general trend but not a strong pattern. For example, in Little bluestem alvar grassland and Scrub conifer / dwarf lake iris alvar shrubland, slightly less than half the observation points had burn evidence present; in Juniper alvar shrubland and Poverty grass dry alvar grassland, slightly more than half the observation points had burn evidence present.

Old eastern white cedar trees were found at some observation points in Little bluestem alvar grassland and Creeping juniper—shrubby cinquefoil alvar shrubland, testifying to a lack of burning at those locations for several centuries (Table 5).

Of the few alvars that are known to have been created by fire since the original surveys, there is one example each of Creeping juniper-shrubby cinquefoil alvar shrubland, Alvar non-vascular pavement and Juniper alvar shrubland, as well as one site that is partly Tufted hairgrass wet alvar grassland and partly a degraded area that may once have been Poverty grass dry alvar grassland. Catling

TABLE 5. Alvar communities in which old eastern white cedar trees (*Thuja occidentalis*) are present. Ages from trees in the Manitoulin Region are minimums, not corrected for gaps in cores or missing pith.

Alvar community type	Location	Oldest tree age
Creeping juniper dwarf shrubland	Great Cloche Island (Manitoulin Region)	>394 in 1996
Creeping juniper dwarf shrubland	Belanger Bay (Manitoulin Island)	>212 in 1996
Creeping juniper dwarf shrubland	Scugog Lake (Bruce Peninsula)	524 in 1995
Little bluestem alvar grassland	Pendall Lake (Bruce Peninsula)	281 in 1995
Little bluestem alvar grassland	Baptist Harbour (Bruce Peninsula)	455 in 1995

and Brownell (1998) also show that Poverty grass dry alvar grassland can be created by fire. Thus several types of alvar communities can be created by fire.

3) Vegetation Dynamics

Results from the comparison of alvars on aerial photos taken 40 to 45 years apart are shown in Table 6.

Creeping juniper—shrubby cinquefoil alvar shrubland appears to be a very stable community type since only one site, part of Foxy Prairie, had an increase in trees. Tufted hairgrass wet alvar grassland sites also appear to be very stable and slow to change. One site, part of Carden Alvar 1, got smaller and gained trees. In addition, Little bluestem alvar grassland is also highly stable, and most openings of this type did not change between aerial photos. Only three openings were larger in the past, all three located on eastern Great Cloche Island. One other site, at Quarry Bay (Manitoulin Island), grew more trees but had no change in size.

Poverty grass dry alvar grassland openings vary in the amount of change they show. About a third of openings of this type have gotten smaller. Two sites have gotten more trees, but two others have gotten fewer trees. Still, a majority of sites (5 out of 8) showed no change.

TABLE 6. Changes observed at observation points in a comparison of aerial photos taken 40–45 years apart. Strongest trends (≥ 66%) are shown in bold type. Observation points are sorted by community type (see Table 4). Grassland, shrubland, pavement and savanna types are grouped together. Sample sizes (in parenthesis) may vary if photo quality was too poor to detect changes, or if no adjacent woods or islands of trees were present. For complete community names, see Table 4.

Structure	Community Type	Little or no change in size	Community was larger in the past	Community was smaller in the past
Grassland	Hairgrass	**86%** (6/7)	14% (1/7)	
	Bluestem	**86%** (19/22)	14% (3/22)	
	Poverty Gr.	**67%** (6/9)	33% (3/9)	
Shrubland	Creeping J.	**100%** (8/8)		
	Juniper Shr	38% (6/16)	56% (9/16)	6% (1/16)
Pavement	Non-vasc	**66%** (2/3)	34% (1/3)	
Savanna	Wcedar-JP		**100%** (3/3)*	
	Mixed conf	33% (1/3)	33% (1/3)*	33% (1/3)

(Continued)

TABLE 6. Continued.

Structure	Community Type	Little or no change in cover	Community was sparser in the past	Community was more vegetated in the past
Grassland	Hairgrass	**100%** (7/7)		
	Bluestem	**94%** (15/16)		6% (1/16)
	Poverty Gr.	63% (5/8)	25% (2/8)	12% (1/8)
Shrubland	Creeping J.	**100%** (7/7)		
	Juniper Shr	27% (4/15)	**67%** (10/15)	6% (1/15)
Pavement	Non-vasc	**100%** (3/3)		
Savanna	Wcedar-JP		**100%** (3/3)*	
	Mixed conf		**100%** (2/2)*	

		Little or no change in # of trees	Community had fewer trees in the past	Community had more trees in the past
Grassland	Hairgrass	**86%** (6/7)	14% (1/7)	
	Bluestem	**82%** (18/22)	18% (4/22)	
	Poverty Gr.	60% (6/10)	20% (2/10)	20% (2/10)
Shrubland	Creeping J.	**88%** (7/8)	12% (1/8)	
	Juniper Shr		**92%** (11/12)	8% (1/12)
Pavement	Non-vasc	**66%** (2/3)	34% (1/3)	
Savanna	Wcedar-JP		**100%** (3/3)*	
	Mixed conf		**100%** (3/3)*	

		Little or no change in adjacent wooded areas	Adjacent wooded areas were more open in the past	Adjacent wooded areas were denser in the past
Grassland	Hairgrass	50% (4/8)	38% (3/8)	12% (1/8)
	Bluestem	**74%** (14/19)	26% (5/19)	
	Poverty Gr.	**44%** (4/9)	44% (4/9)	11% (1/9)
Shrubland	Creeping J.	**83%** (5/6)	17% (1/6)	
	Juniper Shr	44% (4/9)	56% (5/9)	
Pavement	Non-vasc		**100%** (3/3)	
Savanna	Wcedar-JP		**100%** (3/3)	
	Mixed conf		**100%** (2/2)	

		Little or no change in islands/ lines of trees	Islands/lines of trees were smaller or sparser in the past	Islands/lines of trees were larger or denser in the past
Grassland	Hairgrass	50% (4/8)	38% (3/8)	12% (1/8)
	Bluestem	**74%** (14/19)	26% (5/19)	
	Poverty Gr.	30% (3/10)	60% (6/10)	10% (1/10)
Shrubland	Creeping J.	**80%** (4/5)	20% (1/5)	**100%** (7/7)
	Juniper Shr			
Pavement	Non-vasc		**100%** (1/1)	
Savanna	Wcedar-JP		**100%** (3/3)	
	Mixed conf		**100%** (3/3)	

*Savannas that were larger, more open, and not as heavily treed were in fact not savannas in the past.

Juniper alvar shrubland appears to be the most dynamic community type. The majority of sites became more treed, got smaller in size and denser in vegetation. All sites had an increase in the size and density of islands/lines of trees.

Sample sizes for Alvar non-vascular pavement, White cedar-jack pine/ shrubby cinquefoil alvar savanna, and Mixed conifer/common juniper alvar woodland are small and results are probably not conclusive. However, it is worth noting that all savanna and woodland sites had an increase in the number of trees within the alvar opening, in adjacent woodlands, and in lines and islands of trees.

A majority of observation points in Little bluestem alvar grassland and Creeping juniper—shrubby cinquefoil alvar shrubland had little change in adjacent woodlands. The results for woodland change are inconclusive for Tufted hairgrass wet alvar grassland, Poverty grass dry alvar grassland and Juniper alvar shrubland, since observation points were more or less equally split between evidence of woodland change and no change.

DISCUSSION

Land surveyor records show that in all regions of the Great Lakes studied, some alvars existed in locations where alvars occur today, showing that alvars are not necessarily the result of recent anthropogenic disturbance. In northern New York, where there appear to have been forest trees present, there nevertheless are indications that limestone bedrock was visible or not far below the surface, describing a substrate suitable for alvar. On Drummond Island, Michigan, at least two large areas of alvar existed according to Comer et al. 1995.

Furthermore, the surveyor records probably under-represent the amount of alvar that existed because surveyors were instructed to note useable timber species and may have done so even where tree cover was sporadic. Therefore, for current alvar areas where there isn't a strong indication of alvar in the survey records, it is still possible that savanna alvars could have been present. On the other hand, the alvars may have been created since the survey either through natural events or anthropogenic disturbance (such as settlement and clearing of land).

Schaefer and Larson (1997) noted that the alvar-woodland boundary is usually abrupt. The results of our air photo comparison also show it to be fairly stable in most community types, perhaps due to edaphic factors such as bedrock surface or lack of soil, or as a result of grass-tree competition (Wilson, 1998). Poverty grass alvar grasslands showed a variety of changes over a 40–45 year period, but grasslands of this type are typically used as pasture and are more disturbed than other types, so grazing may be playing a role in the observed changes.

Although fire obviously occurs, large, biomass-removing fires have been very infrequent in some regions in recent history. Based on oral history collected on Manitoulin Island, Ontario, there have been very few fires on alvars or fires that created alvars in the last 2 human generations in that region. Also, even where burn evidence is clearly present, it is usually not as extensive or obvious as would be expected if the fires were recent. Although we have observed and had

reports of a few small, local lightning strike fires on alvars (making it possible that small fires of less than one hectare may occur unnoticed by local residents), results suggest fires large enough to create alvars are infrequent events.

Oral accounts from Manitoulin Island show a lack of fire even in some alvars where burn evidence is present, suggesting some of the burn evidence there is easily well over 100 years old. It is not known how long charcoal remains on alvar before it is undetectable, but it is known to last in the top 30 cm of boreal forest soils in our region for up to 250 years (Lynham, pers. comm. 1996). In deep cores from several southern Ontario and western New York locations, charcoal fragments have been dated back to deglaciation 8,000–14,000 years ago (Terasmae and Weeks 1979; Clark et al. 1996). If fire must be used to explain the existence of all alvars, it would mean fire would have to have occurred long enough ago for the evidence to completely disappear on some alvars. Another piece of evidence to suggest the general lack of fires is that alvar sites often have a significant amount of dry, dead (not burned) woody debris present (found at 65% or 125 of 192 observation points in this study). In short, the burn evidence present on alvars may be very old, and the very slow changing alvar communities may not have burned for a long time.

Furthermore, eastern white cedar trees up to 500 years old present on some Little bluestem alvar grassland and Creeping juniper—shrubby cinquefoil alvar shrubland alvars also point to very infrequent fires. Since eastern white cedar is not at all fire-resistant, the areas around these trees definitely have not burned in the lifetime of the trees. This suggests these alvar community types may have a fire return cycle of many centuries or may not burn at all. Alternatively, it allows the possibility of a very small patch burning scenario in which the trees are spared. In either case, a major biomass-removing fire is precluded. With fire return cycles of 200–500 years, and with data showing these alvars change very slowly, fire is probably not the primary factor keeping these alvars in an open state.

Fire may leave no evidence if it occurs in a grassland where there is little woody fuel (Lynham, pers. comm. 1996), which means grassland alvars lacking burn evidence cannot have had significant woody regrowth in the duration of time it takes charcoal to disappear. Still, fire could play a role in maintenance of grassland openness by killing tree seedlings too small to leave much evidence. Reschke (1995) analyzed soil samples from alvars of Chaumont Barrens, New York for microscopic charcoal and found none in alvar grassland soils, although it was present in adjacent areas of juniper alvar shrubland. Grassland fires must happen occasionally, but it is unlikely to be the primary maintaining factor in grasslands across the board because it would necessitate fires every few years, and such fires would have been reported in local newspapers or remembered by nearby residents (especially given the extensive size of some grassland alvars). Yet no reports of this kind of fire have been found.

The alvar community types which showed the strongest correlation with burning were either savannas or woodlands, structural types often maintained by fire in non-alvar situations (for example, Tester 1996). These types also changed more than other alvar types in the air photo comparison. As well, some of our examples of these types have known (recent) burn dates, which suggests a shorter

fire return cycle and more direct role for fire in creation and maintenance of these alvar types. The majority of Juniper alvar shrublands also show these trends and a few have recent burn dates, but not all examples do. This most likely indicates a more flexible fire return interval for Juniper alvar shrubland (sites lacking evidence could still be from very old burns).

With the exception of the savanna types, even the types which correlate well with burn evidence presence still have some sites where no evidence was found despite intensive and skilled searching. Furthermore, old eastern white cedar trees were found at some observation points in Little bluestem alvar grassland and Creeping juniper—shrubby cinquefoil alvar shrubland, testifying to a lack of burning at those locations for several centuries (Table 5). Our data agree with Schaefer and Larson (1997) by showing that within a group of very similar alvars of one community type some examples show burn evidence while others do not. Therefore, for 5 alvar types where burn evidence may be either present or absent (Little bluestem alvar grassland, Creeping juniper—shrubby cinquefoil alvar shrubland, Scrub conifer / dwarf lake iris alvar shrubland, Juniper alvar shrubland and Poverty grass dry alvar grassland), fire has been an incidental or stochastic event rather than an essential occurrence necessary for development or maintenance of the vegetation type.

Some alvars lack any evidence of fire, and it is not necessary to use fire to explain the presence of every alvar. Some of the areas where very old eastern white cedar trees occur are extremely sparsely vegetated (such as on Great Cloche Island and at Scugog Lake, Ontario both with trees >400 years old). Whether these alvars were created by fire prior to the establishment of the oldest trees is nearly irrelevant. The sparseness and lack of burn evidence testify to an exceptionally slow rate of biomass accumulation over five centuries. At this rate of growth, it is reasonable to assume that alvars which are relatively densely vegetated (for example the La Cloche alvar grasslands with 12 cm of soil and a continuous graminoid cover in which no bedrock is exposed) may exhibit the sum of biomass accumulation of their 4000–5000 year existence (since the recession of post-glacial Great Lakes water levels to their current positions). From this it must be concluded that fire should not be used to explain the existence of all Great Lakes alvars, even though it has clearly created some of them.

An important issue for managers of alvar landscapes is whether fire can maintain Great Lakes alvars, or whether it will only reset the successional clock back to zero, and create a new alvar from the beginning. So far, there is little evidence to suggest that regular burning benefits or maintains alvars—other than anecdotal evidence from Pelee Island, Ontario (Dan Lebedyk, Essex [Ontario] Region Conservation Authority pers. comm. 1998), where the alvars contain a significant component of prairie species quite different from all other Great Lakes alvars. Catling and Brownell (1998) maintain that burning increases diversity on alvars, but their study is not readily applicable to alvar maintenance situations because the alvar site they studied was created by burning a forested area, and it was not burned again after the initial fire. In addition, their site features soils 25–200 cm deep, much deeper than is typical in most alvar communities (Reschke et al. 1999).

In New York, at Limerick Cedars, Gilman (1997) has shown there may be

drastic effects from burning alvars. The Perch River Barrens was a pavement savanna prior to a catastrophic fire in 1953. Today, 47 years later, it remains a very barren pavement with only a sparse vegetative cover of lichens and mosses, and a few herbs and shrubs in crevices. Whether this pavement may someday be more highly diverse because of the fire remains to be seen, but if so, it may be on time scales that are difficult to regulate or even correlate with controlled burns.

Our data suggest there are several fire regimes for Great Lakes alvars: 1) there is no fire at all; 2) fire is incidental, with small local fires that do little to alter the community; 3) fire removes biomass creating (and possibly maintaining) savanna alvar types and probably Juniper alvar shrubland; 4) fire clearly removes woody biomass, but does so with long fire return intervals and occasionally catastrophic results, sometimes even creating new alvars.

The Great Lakes alvars have diverse origins, histories and dynamics, and the role of fire can not be generalized across the board. Even using other systems to classify alvars (Catling and Brownell 1999; Brownell and Riley 2000), this diversity of fire history is still apparent. Therefore, it is not appropriate to recommend burning as a management tool for all alvars. We suggest that naturally occurring fire on alvar should be left to burn wherever possible to allow natural successional processes to occur. However, controlled burning should only be planned on a site to site basis and only after careful assessment of what the results might be—possibly including the removal of most of the biomass and soil.

ACKNOWLEDGMENTS

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BOTANICAL WEBSITES

Here are some websites—in no particular order—that may be useful to botanists, both amateurs and professionals. If you have a favorite that is not here, please e-mail me with the URL and an explanation of the site, and I will run further lists when space permits.— The editor

http://www.botany.wisc.edu/wisflora/ This is a fine resource on the flora of Wisconsin, done critically and carefully. The cited specimens are almost entirely those at WIS. There is also a list of the species given for Wisconsin at the USDA site (next below) that apparently do *not* occur in Wisconsin.

http://plants.usda.gov/ This is a listing of vascular plants, with continent-wide range maps, pictures, and other such information. From the large-scale map, one can click on Michigan, for example, and obtain a county-by-county map of a species' range within the state.

http://www.ipni.org/index.html The International Plant Names Index, the online version of Index Kewensis and the Gray Herbarium Cards. It was originally limited to seed plants, but now includes all the names of ferns and fern-allies as well.

http://ridgwaydb.mobot.org/mobot/rarebooks/index.asp The Missouri Botanical Garden has undertaken to scan in a number of rare botanical books. They are freely available to the public, and may be printed off from the website. Otto Kuntze, *Revisio Generum Plantarum*, is here, if you don't have access to the copy in the MICH herbarium library.

http://www.philological.bham.ac.uk/bibliography/index.htm This site is an alphabetical listing of 14,500 books in Latin that have been scanned in, mostly as Adobe.pdf files, but in all cases printable. It is really a guide to dozens of other websites, mostly maintained by some of the great libraries of Europe. Nearly all the important botanical rarities of the 18th and 19th centuries are here.

THE VASCULAR FLORA OF HOG ISLAND, CHARLEVOIX COUNTY, MICHIGAN

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ABSTRACT

The vascular flora of Hog Island, the fourth largest island of the Beaver Island Archipelago, was inventoried. Up to now, some vascular plants have been collected on Beaver Island, but few specimens have been collected from the surrounding islands of the Beaver Island Archipelago. A Floristic Quality Index (FQI) value of 92.7 was calculated, indicating that the island is representative of Michigan's pre-settlement flora. Three hundred and forty species, representing 77 families and 213 genera were collected over three field seasons (2000–2002) with collecting trips made in the spring, summer, and fall. These data were compared to data previously published for the Beaver Island Archipelago. Seventy-three percent of the plant families, 60.5% of the genera, and 43.4% of the species found on the Beaver Island Archipelago as a whole were also found on Hog Island. Among the collections were the threatened species *Cirsium pitcheri, Iris lacustris,* and *Tanacetum huronense; Cypripedium arientinum*, a plant of special concern; and the endangered *Amerorchis rotundifolia*. Seventeen species not previously recorded for the Beaver Island group were documented.

INTRODUCTION

Michigan has a diverse flora (Voss 1972; 1985; 1996). Much of that diversity is found on the islands of Lake Michigan (Penskar et al. 1999). This diversity is reflected in the floras of the Fox Islands (Hazlett et al. 1986; Hazlett 1993), the Manitous (Hazlett & Vande Kopple 1983), and the Grand Traverse Islands (Forzley et al. 1993; Judziewicz 2001). In addition to the inventories, one of the goals of each of the above studies was to identify plants considered to be of special concern, threatened, or endangered either at the state or federal level.

Another island group located in Lake Michigan that has been studied is the Beaver Island Archipelago. The Beaver Island group consists of nine islands: Beaver, Garden, High, Hog, Gull, Trout, Whiskey, Squaw, and Hat. This island group is approximately 30 kilometers west of Emmet County in northern Lake

Michigan, but all of the islands are attached administratively to Charlevoix County. Conifers and flowering plants have been collected from Beaver, Garden, and High Islands. Some of the results of these collections have been published (Voss 1972; 1985; 1996; Hohn 1977; 1980; Penskar et al. 1999) while others have not. Pteridophytes and their allies have also been observed and inventoried on Beaver Island (Veldman & Wujek 1971).

There are published reports of state endangered, threatened, or special concern plant species on Beaver and Garden Islands. These plants include *Cirsium pitcheri* (Pitcher's thistle, threatened), *Iris lacustris* (dwarf lake iris, threatened) (Van Kley & Wujek 1993; Wujek 1998), *Mimulus michiganensis* (Michigan monkey-flower, endangered), *Tanacetum huronense* (Lake Huron tansy, threatened), *Pinguicula vulgaris* (butterwort, special concern) and *Littorella uniflora* (American shore-grass, special concern) (Wujek 1998; Penskar et al. 1999). Also found on Beaver Island are *Castanea dentata* (American chestnut, endangered), *Solidago houghtonii* (Houghton's goldenrod, threatened), *Calypso bulbosa* (calypso, threatened), *Drosera ×anglica* (sundew, special concern), *Cypripedium arietinum* (ram's head lady-slipper, special concern), *Listera auriculata* (auricled twayblade, special concern) and *Carex pallescens* (pale sedge, special concern) (Wujek 1998).

Natural community surveys were conducted on parts of Beaver and Garden Islands in 1998. Four natural community types were identified and recorded: open dunes, boreal forest, mesic northern forest, and northern fen (Penskar et al. 1999).

Hog Island is located approximately eight kilometers northeast of Beaver Island and is part of the Beaver Island Wildlife Research Area, managed by the Michigan Department of Natural Resources. Except for selective logging in the 1950s (P. Gregg, personal communication), Hog Island remains an undeveloped island that has remained relatively undisturbed by man since the arrival of Europeans, making it useful as a baseline for the ecology of the area (Michigan Natural Features Inventory [MNFI], unpublished). As a benchmark for the plant ecology of the area, it is important to have a comprehensive floristic inventory. Researchers from MNFI have made brief visits to the island and noted the occurrence of some threatened and special concern plants, specifically *Solidago houghtonii*, *Iris lacustris*, and *Cirsium pitcheri*, as well as identifying four natural community types, but no comprehensive work has been done (D. Albert, personal communication). In order to generate a comprehensive study of the flora of Hog Island it is important to know what plant species might be expected. The plant species that may be expected in a given area will depend on many factors including the geologic history, and topography of the area, the soil types and plant communities found in the area, and the use of the area by humans.

The goal of this study was to complete a comprehensive floristic inventory of Hog Island. Special attention was paid to species that have State of Michigan special concern, threatened, or endangered status and to the variety of exotics found on the island. Using the floristic inventory, a Floristic Quality Index (FQI) value was calculated for Hog Island in order to determine how representative Hog Island is of Michigan's native biodiversity.

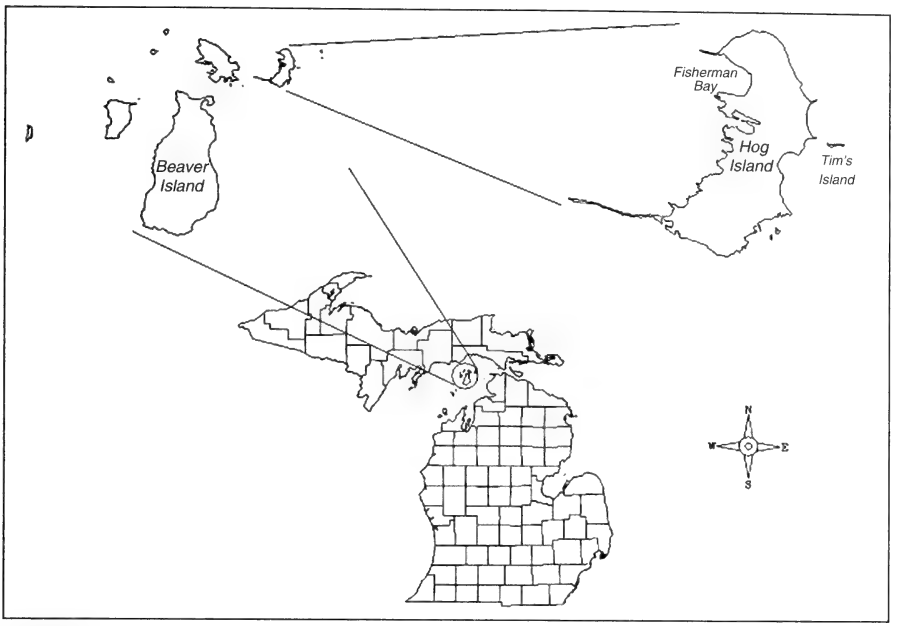

FIGURE 1. Hog Island in relationship to the other islands of the Beaver Island Archipelago and to the state of Michigan.

METHODS AND MATERIALS

Study Site:

Hog Island is the fourth largest island in the Beaver Island Archipelago (Fig. 1), having an area of approximately 10km^2, depending on the lake levels. The elevation of the island ranges from 176–187 m above sea level, and it has an undulating topography. (The average high water level of Lake Michigan is 177.1 m.) The highest point on the island is in the central part of the southern half of the island. Hog Island was below lake levels during both the Lake Algonquin and Lake Nipissing stages of the Great Lakes glacial history (Schaetzl 2002). Therefore, Hog Island has only been exposed for plant colonization for a maximum of 3200 years. Hog Island's bedrock is part of the Bois Blanc formation, which is composed of cherty dolomite, dolomitic limestone, and limestone (Landes et al. 1945).

The plant communities predicted to be on the island by MNFI were Great Lakes marsh, northern wet meadow, bog, conifer swamp, boreal forest, mesic and dry-mesic forests, and rocky beaches (MNFI, unpublished).

Lake Michigan levels have been low the last few years, exposing new shoreline habitat (Center for Operational Oceanographic Products and Services 2003). This exposed habitat would be available for expansion by plant species populations already located on the shore, and for colonization by plant species adapted to disturbed habitats or to those species that had seeds present in the seed bank.

Neither Native Americans nor Europeans ever permanently occupied Hog Island; however, Native Americans used the island to a limited extent for agriculture and both Native Americans and early Europeans used the island for fishing and maple syrup production (MNFI 1988). Before planes carried mail from the mainland to Beaver Island, Hog Island was used as a resting area for horse teams and their drivers on the winter mail run over the ice between Beaver Island and Cross Village.

Hog Island was selectively logged approximately 50 years ago and bulldozed skid paths were made to move the logs (P. Gregg, personal communication). The island is still used for recreation and for research.

As a matter of interest, there are two stories about the origin of Hog Island's name. The first

states that hogs were put on the island to eat the overabundance of water snakes found on the island. The second story says instead that hogs were placed on the island to forage until butchering time. Evidence is lacking to support either story.

Methods:

Vascular plants were collected from Hog Island in the spring (7–10, 24–25 May 2000; 17 May 2001), summer (7, 16–18 July 2000; 25 June 2002), and fall (19 August 2000; 14 September 2001). In order to obtain as complete an inventory as possible, all plant community types predicted to be found on the island by MNFI were searched during spring, summer, and fall. Angiosperms, except for some trees, were collected in flower or with fruits. Gymnosperms were collected without cones, and pteridophytes and their allies were collected with sporangia when possible. Voucher specimens for all taxa listed below are housed in the Central Michigan University Herbarium (CMC). Nomenclature generally follows *Michigan Flora* vol. 1–3 (Voss 1972; 1985; 1996) for gymnosperms, monocots, and dicots and *Flora of North America* vol. 2 *Pteridophytes and Gymnosperms* (Flora of North America Editorial Committee 1993) for ferns and fern allies.

A database of vascular plants reported for the islands of the Beaver Island Archipelago was created, based on data from Veldman and Wujek (1971) and Voss (1972; 1985; 1996). The numbers of taxa (families, genera, species) found on Hog Island were compared to the numbers of taxa found in the rest of the archipelago.

The Floristic Quality Index (FQI) for Hog Island was calculated following the method described in "Floristic Quality Assessment with Wetland Categories and Computer Application Programs for the State of Michigan" (Herman et al. 1996). The above-mentioned procedure is a standardized, repeatable method of determining the floristic quality of an area based upon the native plants found at the site. Native plants have been assigned a coefficient of conservatism (C) value based on the plant's tolerance of disturbance and the fidelity it shows to presettlement-like habitats. The C values range from zero to ten, with zero being associated with the highest disturbance tolerance and least fidelity and ten being associated with the least disturbance tolerance and the greatest fidelity (Herman et al. 1996).

RESULTS

In all, 340 species were collected from Hog Island; included were 17 species not previously reported for the Beaver Island Archipelago (see annotated list). These species represented 77 families and 213 genera. The largest families were Asteraceae (37 species), Cyperaceae (34 species), Poaceae (20 species), Rosaceae (17 species), Orchidaceae (15 species), and Liliaceae (13 species). The largest genera were *Carex* (22 species), *Juncus* (eight species), and *Equisetum* and *Salix* (six species each). State threatened species *Cirsium pitcheri* (Pitcher's thistle), *Tanacetum huronense* (Lake Huron tansy), and *Iris lacustris* (dwarf lake iris) were collected, as was a species of special concern, *Cypripedium arietinum* (ram's head lady-slipper). Only one endangered species, *Amerorchis rotundifolia* (round-leaved orchis), was collected (Michigan Department Natural Resources 1987). A new population of *Iris lacustris*, in addition to the population previously noted (D. Albert, personal communication), was found (45°46′37.4″N 85°21′59.3″W). Forty-two of the 340 species collected on Hog Island were exotic species (12.4% of the Hog Island flora). The Asteraceae contained the greatest number of exotic species (11 species), with four each for the Brassicaceae, Fabaceae, and Poaceae. The FQI value, based on the 298 native species found on Hog Island, was 92.7.

TABLE 1. Relative number of the taxa in the entire Beaver Island Archipelago flora (data from Veldman & Wujek 1971; Voss 1972; 1985; 1996) compared to the Hog Island flora alone

	Beaver Island Archipelago	Hog Island	Percent of B.I.A. flora.
Families	105	77	73.3
Genera	342	213	62.3
Species	745	340	45.6

DISCUSSION

Floristic inventories have been conducted on many of the islands in Lake Michigan, allowing for a comparison of Hog Island's flora to some of the other islands in Lake Michigan. The comparison of vascular plant taxa found on Hog Island to the rest of the Beaver Island Archipelago indicated that the entire Archipelago contained 105 families, 342 genera, and 745 species (Veldman & Wujek 1971; Voss 1972, 1985, 1996). The numbers of families, genera, and species on Hog Island itself were 77 (73.3%), 213 (62.3)%, and 340 (45.6%), respectively, of the taxa found on the entire Beaver Island Archipelago (Table 1).

Two floristic inventory studies have been conducted specifically on Beaver Island. Wujek and Veldman (1971) found 11 families, 19 genera and 44 species of pteridophytes on Beaver Island. Seven families, 11 genera and 23 species of ferns and fern allies were found on Hog Island. Three of the pteridophyte species found on Hog Island were new species for the Beaver Island Archipelago (see annotated list). Jaworski (1979) collected 67 grass species on Beaver Island. The 20 grass species found on Hog Island were previously found on Beaver Island during Jaworski's study.

Hog Island is most similar to Chambers and Summer Islands of the Grand Traverse Islands (GTI) in size and number of species (Table 2). North Fox Island, less than half the size of Hog Island, had approximately the same number of species; whereas South Fox Island, slightly larger than Hog Island, contained 27 more species (Table 2).

The largest families on the Lake Michigan islands studied thus far are the families Asteraceae, Cyperaceae, Poaceae, and Rosaceae. The largest families on Hog Island were Asteraceae, Cyperaceae, Poaceae, Rosaceae, Orchidaceae, and Liliaceae. The three largest families on both Chambers Island and Summer Island were Asteraceae, Poaceae, and Cyperaceae, although the order of Cyperaceae and Poaceae was reversed between the two islands. As for the previous islands, the largest family on both North and South Fox Islands was Asteraceae. On North Fox Island Asteraceae were followed by Cyperaceae, Poaceae, and Rosaceae. On South Fox Island, Cyperaceae were the fourth largest family, preceded by Poaceae and Rosaceae.

Overall, the largest genus on the Lake Michigan islands studied thus far is *Carex*, but other common genera varied by location. On Hog Island, *Carex* was followed by *Juncus*, *Equisetum*, and *Salix*. On Chambers Island, *Polygonum* and *Aster* were the second and third largest genera, respectively; while on Summer Island *Carex* was followed by *Solidago*, *Aster*, *Poa*, and *Viola*. The largest gen-

TABLE 2. A list of the Lake Michigan Islands for which floras have been published, as well as the size of each island and the number of families, number of genera and number of species found on each island. Superscripts denote the studies cited, 1: Judziewicz (2001); 2: Forzley et al. (1993); 3: Hazlett (1993).

Island	Size (ha)	# of Families	# of Genera	# of Species
Hog	1010	77	213	340
Chambers (GTI)[1]	1050	86	229	358
Summer (GTI)[1,2]	891	73	207	376[1]; 165[2]
North Fox[3]	339	69	194	342
South Fox[3]	1321	73	219	367

era on North Fox Island were *Carex* and *Viola*. The largest genera on South Fox Island after *Carex* were *Botrychium*, *Juncus*, *Solidago*, and *Viola*.

Chambers Island is located between Michigan's Upper Peninsula and the Door County Peninsula, making it closer to its western mainland than Hog Island is to its eastern mainland. Chambers Island has a variety of habitat types including hemlock-hardwood forests, remnant Great Lakes pine-barrens, prairie remnants, wetlands, including inland lakes, and undisturbed Great Lakes beach flora. Like Hog Island, Chambers Island is a low-lying island. Hog Island has a variety of habitat types as well, but the types differ from those found on Chambers. For example, Hog Island has no inland lakes. Additionally, while Hog Island was selectively logged in the past, it is no longer logged, while Chambers is still selectively logged (Judziewicz 2001).

Despite its smaller size, Summer Island had more species than Hog Island. Summer Island has potentially been colonized longer than Hog Island because Summer Island has a higher elevation and was above water during the Lake Nipissing stage (Forzley et al. 1993). Summer Island has two or three summer homes plus ATV trails, some of which are used by local people to reach deer hunting sites on State of Michigan land. We speculate that increased disturbance, presumed to be an effect of the activity associated with the homes and trails, may have resulted in more species being introduced onto the island. Hog Island is uninhabited and there are no deer on the island, so the man-made disturbance due to hunting is less. The increased number of species on Summer Island may also be the result of the alvar present on the island. The two forest types found on Summer Island (hardwood forest and a mixed white cedar, balsam fir, red maple, and white birch forest) were also found on Hog Island. Summer Island, like Chambers Island, was also repeatedly selectively logged (Judziewicz 2001).

Portions of North Fox were above lake levels during the Lake Nipissing stage, indicating the island has been available for colonization longer than Hog Island. North Fox has been extensively logged, though it is thought that the island has not been logged for the last 75–85 years. The island was inhabited and an airstrip is still found on the island. The construction of the airstrip necessitated borrow pits, creating a habitat that otherwise would not have been there. North Fox contains many of the same habitat types (northern hardwoods, wet northern hardwoods, lowland conifer forest, dunes, and sandy beach) (Hazlett 1993) as Hog Island.

Portions of South Fox Island were above lake levels during the Lake Algonquin stage as well as the Lake Nipissing stage. South Fox Island does not have the wetlands found on North Fox. South Fox was also logged as well as settled for agriculture. This island also has an airfield. The majority of South Fox Island is a northern hardwood forest, a small portion of which is considered moist northern hardwoods. Overall, South Fox Island does not have the habitat heterogeneity of North Fox Island. South Fox Island does have an extensive dune system, however. Twenty percent of South Fox Island's flora is made up of exotic species while only 11% of North Fox Island's flora is composed of exotic species (Hazlett 1993). The slightly larger size and the longer history of South Fox Island may account for the greater number of species found on that island as compared to Hog Island despite the greater habitat diversity found on Hog Island.

The majority of the collecting for the Beaver Island Archipelago was done on Beaver Island. Hog Island is one-fifteenth the size of Beaver Island but contains nearly half the number of species. This appears to be a large number of species for an island the size of Hog Island but this resembles the pattern noted for herpetofauna of the West Indies (Darlington 1957 as cited by MacArthur & Wilson 1967). Darlington found that "division of area by ten divides the fauna by two." In the case of the Beaver Island Archipelago, division of area by fifteen divides the vascular flora by approximately two if the assumption is made that all the plants collected for the Beaver Island Archipelago are found on Beaver Island because Beaver Island is the largest island in the archipelago. The relationship of area to number of species appears to hold a similar pattern of reduction by half of number of species to a reduction by fifteen of area in the GTI chain (Judziewicz 2001). Beaver and Hog Islands closely match the best-fit line of the species/area curve generated by Judziewicz (2001). South Fox Island also closely matches the best-fit line while North Fox Island has a similar relationship of area to species number as Detroit and Rock Islands of the Grand Traverse Islands (Hazlett 1993; Judziewicz 2001). The best-fit line generated by Judziewicz (2001) for the GTI showed that 70.64% of the variation in species number was due to island size. If Beaver, GTI, Hog, North Fox and South Fox Islands are treated as one group of islands, instead of adding islands to the line generated by Judziewicz (2001), 77.34% of the variation in the number of species is due to island size (Fig. 2).

Many calciphiles were expected on Hog Island because of the limestone-based bedrock. Thirty-two of the 42 calciphiles listed by MNFI (unpublished list) were found on Hog Island (Table 3). Several of these species, including *Castilleja coccinea*, *Geranium robertianum*, *Pentaphylloides floribunda* (*Potentilla fruticosa* of some sources), and *Primula mistassinica,* were found in relative abundance.

Some plants that are commonly found in northern Michigan were not found on Hog Island. Examples of native species that were not found were *Fagus grandifolia* (beech), *Betula alleghaniensis* (yellow birch) and *Acer pensylvanicum* (striped maple). The beech may not have arrived on the island because the seeds are too large for most birds to carry, and humans have not planted beech on the island. The fruits of both the yellow birch and striped maple are wind-dispersed,

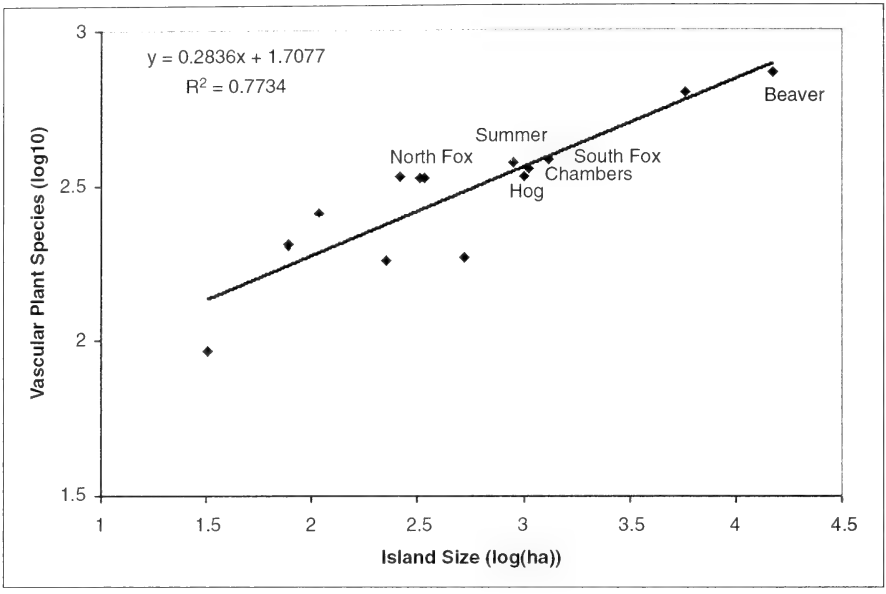

FIGURE 2. Species area curve of vascular plants calculated for the Grand Traverse Islands (Judziewicz 2001), North Fox and South Fox Islands (Hazlett 1993), Beaver Island (Veldman & Wujek 1971; Voss 1972; 1985; 1996), and Hog Island (this study).

however. Therefore, it was surprising that these two species were not found, especially because other species of birch and maple and appropriate habitat for each were found on Hog Island. Houghton's goldenrod was not found on the island in the course of the present study. Researchers from MNFI had found this threatened plant on Hog Island earlier (D. Albert, personal communication). This species may not have been noted during this study because the population observed previously may have become extirpated, perhaps due to lower lake levels and plant succession. Another possibility is that the latest collecting date (14 September 2001) was too early for collecting Houghton's goldenrod because it is one of the last species to bloom in the autumn.

Some common exotic species were also missing from the island: *Daucus carota* (Queen Anne's lace), *Capsella bursa-pastoris* (shepherd's purse), *Plantago lanceolata* (narrow-leaved plantain), *Plantago major* (common plantain), *Linaria vulgaris* (common butter and eggs) and exotic *Lonicera* species (honeysuckles). All of these species are fairly common on Beaver Island and the mainland.

Hog Island does have 42 exotic species, however. Exotic species comprise 12.4% of Hog Island's flora, which is on the lower end of the predicted values of 10–30% for the percentage of exotics found in any given flora (Mills et al. 1993). The exotics found on the island may be, in part, the result of human influence. Even though the island is uninhabited, it has been, and continues to be, used by humans. Seeds from exotic plants could have been inadvertently carried to the island on clothing or in supplies. Animals may have dispersed the seeds

TABLE 3. List of calciphiles commonly found in Michigan based on an unpublished list generated by Michigan Natural Features Inventory. Bolded species are those found on Hog Island.

Alnus rugosa	*Liparis loeselii*
Betula pumila	***Lobelia kalmii***
Calamintha arkansana	***Menyanthes trifoliata***
Carex buxbaumii	*Myrica gale*
Carex capillaris	***Pentaphylloides floribunda***
Carex eburnea	***Potentilla palustris***
Carex lasiocarpa	***Primula mistassinica***
Carex leptalea	***Rhamnus alnifolia***
Carex limosa	***Rhynchospora alba***
Castilleja coccinea	***Rhynchospora capillacea***
Cladium mariscoides	*Salix pedicellaris*
Cypripedium reginae	***Sarracenia purpurea***
Cystopteris bulbifera	***Scirpus hudsoniana***
Drosera linearis	***Selaginella selaginoides***
Dulichium arundinaceum	***Shepherdia canadensis***
Eleocharis pauciflora	*Solidago houghtonii*
Geranium robertianum	***Thuja occidentalis***
Hypericum kalmianum	***Tofieldia glutinosa***
Iris lacustris	***Triglochin maritimum***
Juncus balticus	***Utricularia cornuta***
Larix laricina	***Zigadenus glaucus***

from exotic plants either by carrying the seeds or by eating the fruit and defecating the seeds on the island. The successional stage of the island may also play a role in the number of exotic species found on the island. The island has been left relatively undisturbed since it was logged in the 1950s. Most of that disturbed area is now once again northern hardwood forest. Most of the present day disturbed area is limited to habitat found only along the lakeshore. Therefore, preferred habitat for exotic species is limited.

The majority of Hog Island's flora is composed of native species, reflected by the high Floristic Quality Index (FQI) value for the island (92.7). An FQI value of over 50 indicates a rare community that represents a substantial component of Michigan's native biodiversity (Herman et al. 1996). The high FQI value for Hog Island is due to the fact that 33 of Hog Island's 298 native plants had a C-value of 10 and over half of the species (187) had a C-value of five or greater. The species with high C-values are likely found on Hog Island because it has experienced little disturbance relative to other islands in Lake Michigan and to the mainland. Additionally, the habitats found on Hog Island are intact and grade into one another. The habitats are not separated from each other by man-made disturbance and little, if any, natural disturbance. Therefore, there are zones of overlap between habitats. These zones of overlap may be appropriate habitat for specific species.

Hog Island contains a large number of pre-settlement plant species and is very representative of Michigan native biodiversity. As mentioned previously, there appear to be no deer on the island, as evidenced by the presence of tall *Taxus canadensis* (yew) and the absence of a browse line. The island could, therefore, be a useful study site for researchers interested in questions related to pre-

settlement Michigan's plant ecology. One hopes that deer will not be introduced onto the island, even though appropriate habitat is found on Hog Island, and that the island will continue to be protected.

ANNOTATED LIST OF VASCULAR PLANTS

The following is a species list for Hog Island, a member of the Beaver Island Archipelago, Charlevoix County, Michigan. Nomenclature, in general, follows Voss (1972; 1985; 1996) and FNA (1993). Coefficient of Conservatism values (C) are listed to the right of each species. An asterisk indicates an exotic species (Herman et al. 1996). Species printed in bold are reported for the first time for the Beaver Island Archipelago. State of Michigan status (E = endangered, T = threatened, SC = special concern) is noted to the left of relevant species.

PTERIDOPHYTES	*C*
LYCOPODIACEAE	
Huperzia lucidula (Michx.) Trevisan (shining fir-moss)	5
Lycopodium annotinum L. (bristly club-moss)	5
Lycopodium clavatum L. (common club-moss)	4
Lycopodium obscurum L. (flat-branched tree club-moss)	5
SELAGINELLACEAE	
Selaginella apoda (L.) Spring (meadow spike-moss)	5
***Selaginella eclipes* Buck** (Buck's spike-moss)	5
Selaginella selaginoides (L.) de Beauvois (northern spike-moss)	10
EQUISETACEAE	
Equisetum arvense L. (field horsetail)	0
Equisetum fluviatile L. (river horsetail)	7
Equisetum hyemale L. (common scouring-rush)	2
***Equisetum ×nelsonii* (A. A. Eaton) Schaffner** (Nelson's horsetail)	8
Equisetum palustre L. (marsh horsetail)	10
Equisetum variegatum Schleich. (variegated scouring-rush)	8
DENNSTAEDTIACEAE	
Pteridium aquilinum (L.) Kuhn var. *latiusculum* (Desvaux) L. Underwood (bracken)	0
DRYOPTERIDACEAE	
***Dryopteris clintoniana* (D.C. Eaton) Dowell** (Clinton's wood fern)	8
Dryopteris cristata (L.) Gray (crested wood fern)	6
Dryopteris intermedia (Muhl.) Gray (evergreen wood fern)	5
Dryopteris marginalis (L.) Gray (marginal wood fern)	5
Gymnocarpium dryopteris (L.) Newman (common oak fern)	5
Matteucia struthiopteris (L.) Todaro var. *pensylvanica* (Willd.) C.V. Morton (ostrich fern)	3
Onoclea sensibilis L. (sensitive fern)	2
OPHIOGLOSSACEAE	
Botrychium virginianum (L.) Swartz (rattlesnake fern)	5

THELYPTERIDACEAE
Thelypteris palustris Schott var. *pubescens* (Lawson) Fernald (marsh fern) 2

GYMNOSPERMS

CUPRESSACEAE
Juniperus communis L. (ground juniper) 4
Juniperus horizontalis Moench (creeping juniper) 10
Thuja occidentalis L. (northern white cedar) 4

PINACEAE
Abies balsamea (L.) Miller (balsam fir) 3
Larix laricina (DuRoi) K. Koch (tamarack) 5
Picea glauca (Moench) A. Voss (white spruce) 3
Picea mariana (Miller) BSP (black spruce) 6
Pinus strobus L. (white pine) 3

TAXACEAE
Taxus canadensis Marsh. (yew) 5

MONOCOTS

ALISMATACEAE
Sagittaria latifolia Willd. (wapato) 1

ARACEAE
Arisaema triphyllum (L.) Schott (Jack-in-the-pulpit) 5

CYPERACEAE
Carex aquatilis Wahl. (water sedge) 7
Carex atlantica Bailey (Atlantic sedge) 7
Carex aurea Nutt. (golden sedge) 3
Carex bebbii (Bailey) Fern. (Bebb's sedge) 4
Carex buxbaumii Wahl. (Buxbaum's sedge) 10
Carex capillaris L. (hairlike sedge) 9
Carex deweyana Schw. (Dewey's sedge) 3
Carex diandra Schrank (bog panicled sedge) 8
Carex disperma Dewey (two-seeded bog sedge) 10
Carex eburnea Boott (ebony sedge) 7
Carex flava L. (yellow sedge) 4
Carex garberi Fern. (elk sedge) 8
Carex hystericina Willd. (bottlebrush sedge) 2
Carex lasiocarpa Ehrh. (narrow-leaved wooly sedge) 8
Carex leptalea Wahl. (bristle-stalked sedge) 5
Carex limosa L. (muck sedge) 10
Carex peckii Howe (Peck's sedge) 3
Carex pedunculata Willd. (long-stalked sedge) 5
Carex pseudo-cyperus L. (cypresslike sedge) 5
Carex retrorsa Schw. (retrorse sedge) 3
Carex trisperma Dewey (three-fruited sedge) 9
Carex viridula Michx. (little green sedge) 4
Cladium mariscoides (Muhl.) Torrey (twig-rush) 10
Eleocharis acicularis (L.) R. & S. (needle spikerush) 7
Eleocharis elliptica Kunth (elliptic spikerush) 6
Eleocharis pauciflora (Lightf.) Link (small-flowered spikerush) 10
Eleocharis smallii Britton (Small's spikerush) 5
Eriophorum viridi-carinatum (Engelm.) Fern. (dark-scale cotton-grass) 8

	Rhynchospora alba (L.) Vahl (white beakrush)	6
	Rhynchospora capillacea Torrey (hairlike beakrush)	10
	Schoenoplectus acutus (Bigelow) A. & D. Löve (hardstem bulrush)	5
	Schoenoplectus pungens (Vahl.) Palla (common three-square bulrush)	5
	Scirpus cyperinus (L.) Kunth (wool-grass)	5
	Trichophorum hudsonianus (Michx.) Fern. (Hudson's bulrush)	1
IRIDACEAE		
T	*Iris lacustris* Nutt. (dwarf lake iris)	9
	Iris versicolor L. (wild blue flag)	5
	Sisyrinchium montanum Greene (mountain blue-eyed grass)	4
JUNCACEAE		
	Juncus alpinus Vill. (alpine rush)	5
	Juncus articulatus L. (jointed rush)	3
	Juncus balticus Willd. (Baltic rush)	4
	Juncus brevicaudatus (Engelm.) Fern. (narrow-panicled rush)	8
	Juncus canadensis La Harpe (Canadian rush)	6
	Juncus dudleyi Wieg. (Dudley's rush)	1
	Juncus nodosus L. (joint rush)	5
	Juncus pelocarpus Meyer (brown-fruited rush)	8
JUNCAGINACEAE		
	Triglochin maritimum L. (common bog-arrow grass)	8
	Triglochin palustre L. (marsh bog-arrow grass)	8
LILIACEAE		
	Allium tricoccum Aiton (wild leek)	5
	Clintonia borealis (Aiton) Raf. (bluebead lily)	5
	Erythronium americanum Ker (yellow trout lily)	5
	Lilium philadelphicum L. (wood lily)	10
	Maianthemum canadense Desf. (Canada mayflower)	4
	Polygonatum pubescens (Willd.) Pursh (Solomon's-seal)	5
	Smilacina racemosa (L.) Desf. (false spikenard)	5
	Smilacina stellata (L.) Desf. (starry false Solomon's-seal)	5
	Streptopus roseus Michx. (rosy twisted stalk)	5
	Tofieldia glutinosa (Michx.) Pers. (false asphodel)	10
	Trillium cernuum L. (nodding trillium)	5
	Trillium grandiflorum (Michx.) Salisb. (common trillium)	5
	Zigadenus elegans Pursh subsp *glaucus* (Nutt.) Hulten (white camas)	10
ORCHIDACEAE		
E	***Amerorchis rotundifolia* (Banks ex Pursh) Hultén** (round-leaved orchis)	10
	Calopogon tuberosus (L.) BSP (grass-pink)	9
	Corollorhiza maculata Raf. (spotted coralroot)	5
	Corollorhiza striata Lindley (striped coralroot)	6
	Corollorhiza trifida Chat. (early coralroot)	6
SC	*Cypripedium arietinum* R. Br. (ram's head lady-slipper)	10
	Cypripedium calceolus L. var. *pubescens* (Willd.) Correll (yellow lady-slipper)	5
	Cypripedium reginae Walter (showy lady-slipper)	9
	***Epipactis helleborine* (L.) Crantz** (helleborine orchid)	*
	Goodyera oblongifolia Raf. (green-leaved rattlesnake-plantain)	6
	Goodyera tesselata Lodd. (checkered rattlesnake-plantain)	6
	Platanthera hyperborea (L.) Lindley (tall northern bog orchid)	5
	Platanthera psycodes (L.) Lindley (purple fringed orchid)	7
	Pogonia ophioglossoides (L.) Ker (rose pogonia)	10
	Spiranthes cernua (L.) Rich. (nodding ladies-tresses)	4

POACEAE

Agropyron trachycaulum (Link) Malte (wheatgrass)	8
Agrostis gigantea Roth (redtop)	*
Agrostis hyemalis (Walter) BSP (ticklegrass)	4
Ammophila breviligulata Fern. (beach grass)	10
Calamagrostis canadensis (Michx.) Beauv. (blue-joint)	3
Calamovilfa longifolia (Hooker) Scribner (sand-reed)	10
Danthonia spicata (L.) R. & S. (poverty grass)	4
Elymus canadensis L. (Canada wild-rye)	7
Festuca obtusa Biehler (nodding fescue)	5
Glyceria striata (Lam.) Hitchc. (fowl manna grass)	4
Muhlenbergia glomerata (Willd.) Trin. (marsh wild-timothy)	10
Oryzopsis asperifolia Michx. (rice-grass)	6
Panicum capillare L. (witch grass)	1
Panicum implicatum Britton (wooly panic grass)	3
Phalaris arundinacea L. (reed canary grass)	0
Phragmites australis (Cav.) Steudel (reed)	1
Poa annua L. (annual bluegrass)	*
Poa compressa L. (Canada bluegrass)	*
Poa pratensis L. (Kentucky bluegrass)	*
Schizachyrium scoparium (Michx.) Nash (little bluestem)	5

POTAMOGETONACEAE

Potamogeton filiformis Pers. (thread-leaved pondweed)	7

TYPHACEAE

Typha angustifolia L. (narrow-leaved cat-tail)	*
Typha latifolia L. (common cat-tail)	1

XYRIDACEAE

Xyris montana Ries (yellow-eyed grass)	10

DICOTS

ACERACEAE

Acer rubrum L. (red maple)	1
Acer saccharum Marsh. (sugar maple)	5
Acer spicatum Lam. (mountain maple)	5

ANACARDIACEAE

Rhus typhina L. (staghorn sumac)	2
Toxicodendron radicans (L.) Kuntze (poison ivy)	2

APIACEAE

Cicuta bulbifera L. (bulblet water-parsnip)	5
Heracleum maximum Bartram (cow-parsnip)	3
Osmorhiza claytonii (Michx.) C. B. Clarke (hairy sweet-cicely)	4
Pastinaca sativa L. (wild parsnip)	*
Sanicula marilandica L. (black snakeroot)	4
Taenidia integerrima (L.) Drude (yellow-pimpernel)	8

AQUIFOLIACEAE

Ilex verticillata (L.) A. Gray (Michigan holly)	5
Nemopanthus mucronatus (L.) Loes. (mountain holly)	7

ARALIACEAE

Aralia nudicaulis L. (wild sarsaparilla)	5

	Aralia racemosa L. (spikenard)	8
	ASCLEPIADACEAE	
	Asclepias incarnata L. (swamp milkweed)	6
	Asclepias syriaca L. (common milkweed)	1
	ASTERACEAE	
	Achillea millefolium L. (yarrow)	1
	Anaphalis margaritacea (L.) Bentham (pearly everlasting)	3
	Arctium minus Bernh. (common burdock)	*
	Artemisia absinthium L. (common wormwood)	*
	Aster borealis (T. & G.) Prov. (rush aster)	9
	Aster lanceolatus Willd. (panicled aster)	2
	Aster macrophyllus L. (large-leaved aster)	4
	Aster pilosus Willd. (frost aster)	1
	Bidens connatus Willd. (purple-stemmed beggar-ticks)	5
	Centaurea maculosa Lam. (spotted knapweed)	*
	Cirsium arvense (L.) Scop. (field thistle)	*
	Cirsium palustre (L.) Scop. (marsh thistle)	*
T	*Cirsium pitcheri* (Eaton) T. & G. (Pitcher's thistle)	10
	Cirsium vulgare (Savi) Tenore (bull thistle)	*
	Coreopsis lanceolata L. (lance-leaved tickseed)	8
	Erigeron philadelphicus L. (Philadelphia fleabane)	2
	Erigeron strigosus Willd. (daisy fleabane)	4
	Eupatorium maculatum L. (Joe-pye-weed)	4
	Eupatorium perfoliatum L. (boneset)	4
	Euthamia graminifolia (L.) Nutt. (grass-leaved goldenrod)	3
	Hieracium aurantiacum L. (orange hawkweed)	*
	Hieracium kalmii L. (Canada hawkweed)	3
	Hieracium piloselloides Vill. (yellow hawkweed)	*
	Krigia virginica (L.) Willd. (dwarf-dandelion)	4
	Lactuca canadensis L. (wild lettuce)	2
	Leucanthemum vulgare Lam. (ox-eye daisy)	*
	***Prenanthes racemosa* Michx.** (colt's foot)	8
	Senecio pauperculus Michx. (northern ragwort)	3
	Solidago altissima L. (tall goldenrod)	1
	Solidago canadensis L. (Canada goldenrod)	1
	Solidago gigantea Aiton (late goldenrod)	3
	Solidago ohioensis Riddell (Ohio goldenrod)	8
	Solidago simplex Kunth (Gillman's goldenrod)	10
	Sonchus arvensis L. (field sow-thistle)	*
T	*Tanacetum huronense* Nutt. (Lake Huron tansy)	10
	Taraxacum officinale Wiggers (common dandelion)	*
	Tragopogon dubius Scop. (goat's-beard)	*
	BALSAMINACEAE	
	Impatiens capensis Meerb. (spotted touch-me-not)	2
	BERBERIDACEAE	
	Caulophyllum thalictroides (L.) Michx. (blue cohosh)	5
	BETULACEAE	
	Betula papyrifera Marsh. (paper birch)	2
	Corylus cornuta Marsh. (beaked hazelnut)	5
	Ostrya virginiana (Miller) K. Koch (ironwood)	5

BRASSICACEAE
- ***Arabis divaricarpa* A. Nelson** (spreading-pod rock-cress) 6
- *Arabis lyrata* L. (sand cress) 7
- *Barbarea vulgaris* R. Br. (yellow rocket) *
- *Brassica juncea* (L.) Czern. (Indian mustard) *
- *Cakile edentula* (Bigelow) Hooker (sea-rocket) 5
- *Descurainia pinnata* (Walter) Britton (tansy mustard) *
- *Lepidium campestre* (L.) R. Br. (fieldcress) *
- *Rorippa palustris* (L.) Besser (yellow cress) 1

CAMPANULACEAE
- *Campanula aparinoides* Pursh (marsh bellflower) 7
- *Campanula rotundifolia* L. (bluebell) 6
- *Lobelia kalmii* L. (Kalm's lobelia) 10

CAPRIFOLIACEAE
- *Diervilla lonicera* Miller (bush honeysuckle) 4
- *Linnaea borealis* L. (twinflower) 6
- *Lonicera canadensis* Marshall (fly honeysuckle) 5
- *Lonicera dioica* L. (glaucous honeysuckle) 5
- *Sambucus racemosa* L. (red-berried elder) 3
- *Viburnum acerifolium* L. (maple-leaved viburnum) 6
- *Viburnum opulus* L. var. *americanum* Aiton (highbush-cranberry) 5

CARYOPHYLLACEAE
- *Arenaria stricta* Michx. (rock sandwort) 10
- *Silene vulgaris* (Moench) Garcke (bladder campion) *

CHENOPODIACEAE
- *Chenopodium album* L. (lamb's-quarters) *

CLUSIACEAE
- *Hypericum perforatum* L. (common St. John's-wort) *

CONVOLVULACEAE
- *Calystegia sepium* (L.) R. Br. (hedge bindweed) 2

CORNACEAE
- *Cornus amomum* Miller (pale dogwood) 2
- *Cornus canadensis* L. (bunchberry) 6
- *Cornus rugosa* Lam. (round-leaved dogwood) 6
- *Cornus stolonifera* Michx. (red-osier) 2

CRASSULACEAE
- *Sedum acre* L. (mossy stonecrop) *

DROSERACEAE
- *Drosera linearis* Goldie (narrow-leaved sundew) 10
- *Drosera rotundifolia* L. (round-leaved sundew) 6

ELAEAGNACEAE
- *Shepherdia canadensis* (L.) Nutt. (soapberry) 7

ERICACEAE
- *Andromeda glaucophylla* Link (bog-rosemary) 10
- *Arctostaphylos uva-ursi* (L.) Sprengel (bearberry) 8
- *Vaccinium oxycoccos* L. (small cranberry) 8

FABACEAE
Lathyrus japonicus Willd. (beach pea) 10
Lotus corniculata L. (birdfoot trefoil) *
Medicago lupulina L. (black medic) *
Melilotus alba Medicus (white sweet-clover) *
Trifolium pratense L. (red clover) *

FAGACEAE
Quercus rubra L. (red oak) 5

GENTIANACEAE
Gentiana rubricaulis Schwein. (red-stemmed gentian) 7
Gentianopsis procera (Holm) Ma (lesser fringed gentian) 8

GERANIACEAE
Geranium robertianum L. (herb Robert) 3

GROSSULARIACEAE
Ribes americanum Miller (wild black currant) 6
Ribes lacustre (Pers.) Poiret (swamp black currant) 6

HALORAGACEAE
***Myriophyllum heterophyllum* Michx.** (milfoil) 6
Proserpinaca palustris L. (mermaid-weed) 6

LAMIACEAE
Calamintha arkansana (Nutt.) Shinners (calamint) 10
Clinopodium vulgare L. (wild basil) 3
Leonurus cardiaca L. (motherwort) *
Lycopus americanus W. P. C. Barton (common water-horehound) 2
Lycopus uniflorus Michx. (northern bugleweed) 2
Mentha arvensis L. (wild mint) 3
Mentha ×piperita L. (peppermint) *
Prunella vulgaris L. (self-heal) *
Scutellaria galericulata L. (marsh skullcap) 5

LENTIBULARIACEAE
Utricularia cornuta Michx. (horned bladderwort) 10

MALVACEAE
Malva neglecta Wallr. (common mallow) *

MENYANTHACEAE
Menyanthes trifoliata L. (buckbean) 8

MONOTROPACEAE
Monotropa uniflora L. (Indian pipe) 5

OLEACEAE
Fraxinus nigra Marsh. (black ash) 6
Fraxinus pennsylvanica Marsh. (green ash) 2

ONAGRACEAE
Circaea alpina L. (small enchanter's-nightshade) 4
Epilobium angustifolium L. (fireweed) 3
Epilobium ciliatum Raf. (willow-herb) 3
***Epilobium hirsutum* L.** (great hairy willow-herb) *

Epilobium leptophyllum Raf. (marsh willow-herb)	6
***Epilobium parviflorum* Schreber** (willow-herb)	*
Oenothera oakesiana (A. Gray) Watson & Coulter (Oakes' evening-primrose)	8
POLYGALACEAE	
Polygala paucifolia Willd. (fringed polygala)	7
POLYGONACEAE	
Polygonum amphibium L. (water smartweed)	6
Polygonum lapathifolium L. (willow-weed)	0
Polygonum persicaria L. (lady's-thumb)	*
Polygonum ramosissimum Michx. (bushy knotweed)	7
Rumex crispus L. (curly dock)	*
PORTULACACEAE	
Claytonia caroliniana Michx. (spring-beauty)	6
PRIMULACEAE	
Lysimachia terrestris (L.) BSP (swamp candles)	6
Primula mistassinica Michx. (bird's-eye primrose)	10
Trientalis borealis Raf. (star-flower)	5
PYROLACEAE	
Pyrola asarifolia Michx. (pink shinleaf)	8
***Pyrola chlorantha* Sw.** (green-flowered wintergreen)	8
***Pyrola rotundifolia* L.** (shinleaf)	7
RANUNCULACEAE	
Actaea pachypoda Ell. (white baneberry)	7
Anemone canadensis L. (Canada anemone)	4
Anemone multifida Poiret (red anemone)	10
Aquilegia canadensis L. (wild columbine)	5
Caltha palustris L. (marsh marigold)	6
Coptis trifolia (L.) Salisb. (goldthread)	5
***Hepatica acutiloba* DC** (sharp-lobed hepatica)	8
Ranunculus abortivus L. (small-flowered buttercup)	0
Ranunculus acris L. (tall crowfoot)	*
Ranunculus sceleratus L. (cursed crowfoot)	1
***Thalictrum dasycarpum* Fisch. & Ave-Lall.** (purple meadow-rue)	3
Thalictrum dioicum L. (early meadow-rue)	6
RHAMNACEAE	
Rhamnus alnifolia L'Her. (alder-leaved buckthorn)	8
ROSACEAE	
Amelanchier arborea (F. Michx.) Fern. (downy juneberry)	4
Amelanchier laevis Wieg. (smooth serviceberry)	4
Argentina (Potentilla) anserina (L.) Rydb. (silverweed)	5
Aronia prunifolia (Marsh.) Rehder (chokeberry)	5
Fragaria virginiana Miller (wild strawberry)	2
Geum canadense Jacq. (white avens)	1
Pentaphylloides floribunda (Pursh) A. Löve (shrubby cinquefoil)	10
Physocarpus opulifolius (L.) Maxim. (ninebark)	4
Potentilla norvegica L. (rough cinquefoil)	0
Potentilla palustris (L.) Scop. (marsh cinquefoil)	7
Prunus pumila L. (sand cherry)	8

Prunus virginiana L. (choke cherry)	2
Rosa acicularis Lindley (prickly rose)	4
Rosa blanda Aiton (smooth rose)	3
Rubus pubescens Raf. (dwarf raspberry)	4
Rubus strigosus Michx. (wild red raspberry)	2
Sorbus decora (Sarg.) Schneider (showy mountain ash)	4
RUBIACEAE	
Galium aparine L. (goosegrass)	0
Galium brevipes Fernald & Wiegand (limestone swamp bedstraw)	6
Galium palustre L. (marsh bedstraw)	3
Galium triflorum Michx. (sweet-scented bedstraw)	4
Mitchella repens L. (partridgeberry)	5
SALICACEAE	
Populus balsamifera L. (balsam poplar)	2
Populus tremuloides Michx. (quaking aspen)	1
Salix candida Willd. (sage willow)	9
Salix discolor Muhl. (pussy willow)	1
Salix exigua Nutt. (sandbar willow)	1
Salix lucida Muhl. (shining willow)	3
Salix myricoides Muhl. (blueleaf willow)	9
Salix petiolaris J. E. Smith (slender willow)	1
SANTALACEAE	
Comandra umbellata (L.) Nutt. (bastard-toadflax)	5
Geocaulon lividum (Richardson) Fern. (northern comandra)	9
SARRACENIACEAE	
Sarracenia purpurea L (pitcher-plant)	10
SAXIFRAGACEAE	
Mitella nuda L. (naked miterwort)	8
Parnassia glauca Raf. (grass-of-parnassus)	8
SCROPHULARIACEAE	
Agalinis purpurea (L.) Pennell (purple false foxglove)	7
Castilleja coccinea (L.) Sprengel (Indian paintbrush)	8
Melampyrum lineare Desr. (cow-wheat)	6
Mimulus ringens L. (monkey-flower)	5
Verbascum thapsus L. (common mullein)	*
Veronica anagallis-aquatica L. (water-speedwell)	4
SOLANACEAE	
Solanum dulcamara L. (nightshade)	*
Solanum ptychanthum Dunal (black nightshade)	1
TILIACEAE	
Tilia americana L. (basswood)	5
URTICACEAE	
***Boehmeria cylindrica* (L.) Sw.** (false nettle)	5
Urtica dioica L. (stinging nettle)	1
VERBENACEAE	
Verbena hastata L. (hoary vervain)	4

VIOLACEAE

Viola canadensis L. (Canada violet)	5
Viola conspersa Reichenb. (dog violet)	3
***Viola nephrophylla* Greene** (northern bog violet)	8
Viola pubescens Aiton (yellow violet)	4
Viola renifolia A. Gray (kidney-leaved violet)	6

VITACEAE

Vitis riparia Michx. (river-bank grape)	3

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THE VEGETATION AT POINT AU SAUBLE NATURE PRESERVE, BROWN COUNTY, WISCONSIN, USA.

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ABSTRACT

I conducted an ecological study of Point au Sauble Nature Preserve on the east shore of Green Bay, Brown County, Wisconsin. *Typha latifolia* and *Phragmites australis* were the most common herbaceous species found at the Point au Sauble Nature Preserve. *Acer negundo* was the most common tree species detected. Of the 46 species found, 15 were exotic/invasive species. The introduction of exotic/invasive species at the Preserve may be from migratory birds, continual wave action from Green Bay, and/or anthropogenic disturbance. The current low-water years in the Great Lakes Basin has allowed the invasive species *P. australis* to colonize the inner wetland of Point au Sauble. As a part of this research, I developed a permanent sampling grid to be used by future student and faculty researchers to monitor the vegetation at the Point au Sauble Nature Preserve.

INTRODUCTION

The Point au Sauble Nature Preserve is a prominent peninsula located on the east shore of the Lower Green Bay (Fig. 1) and constitutes one of the few unmodified estuarine wetlands in the entire Lake Michigan ecosystem (Paulios 2001). The Preserve consists of flood plain forest, shrub-carr, sedge meadow, emergent aquatic, open water, and beach habitats (Paulios 2001). The interior of Point au Sauble consists of a large coastal wetland (Fig. 1). The lagoon is connected to the bay to the south. Because of this connection, the composition and diversity of vegetation within the lagoon and surrounding area are likely affected by changing Lake Michigan water levels.

The only current long-term research conducted at Point au Sauble is bird surveys conducted during the spring and fall migration periods and water level monitoring in the lagoon (Paulios 2001). No studies have looked at the vegetation of this dynamic ecosystem.

According to historical maps, no public road has ever crossed the peninsula and residential development was restricted (Paulios 2001). Point au Sauble is now owned and managed by the University of Wisconsin-Green Bay and so will continue to have limited human disturbance. This presents an excellent opportunity to study the vegetation of a relatively unmodified estuarine wetland and surrounding flood-plain forest.

The major objectives of this study were to: (1) develop a permanent vegetation sampling grid at the Point au Sauble Nature Preserve, (2) conduct a baseline

FIGURE 1.

survey of extant vegetation for the 2002 growing season and (3) develop a standardized protocol for subsequent annual vegetation sampling events.

METHODS

Baseline Survey

The vegetation at Point au Sauble was surveyed in September 2002. Sampling points were chosen by laying a 100 meter grid over a 2000 digital ortho-photo (DOP) of Point au Sauble. Each grid point corresponds to a Wisconsin Transverse Mercator (WTM) coordinate that was used to locate the exact sampling spot in the field using a handheld Geographic Positioning System (GPS) unit. A nested quadrat design was used to sample the vegetation. At each plot, percent ground cover, percent vegetation cover and diameter-at-breast height (dbh) of trees were taken in a $10m^2$ quadrat. In the middle of this large quadrat was a smaller $1m^2$ quadrat, where the percent cover of each species within cover classes was estimated. A six-point standard cover-abundance scale (modified from Daubenmire 1959) was used: (1) 0–5%, (2) 5–25%, (3) 26–50%, (4) 51–75%, (5) 76–95%, and (6) 95–100%; midpoints of each class were used to estimate cover. Plant nomenclature follows Voss (1972; 1985; 1996). Mann-Whitney U tests were used on all comparisons of mean percent cover. Selected plant voucher specimens are deposited at UWGB.

RESULTS AND DISCUSSION

Forty-six species of herbaceous, tree, and shrub species were recorded at Point au Sauble. Of these, 31 were native and 15 were exotic/invasive species

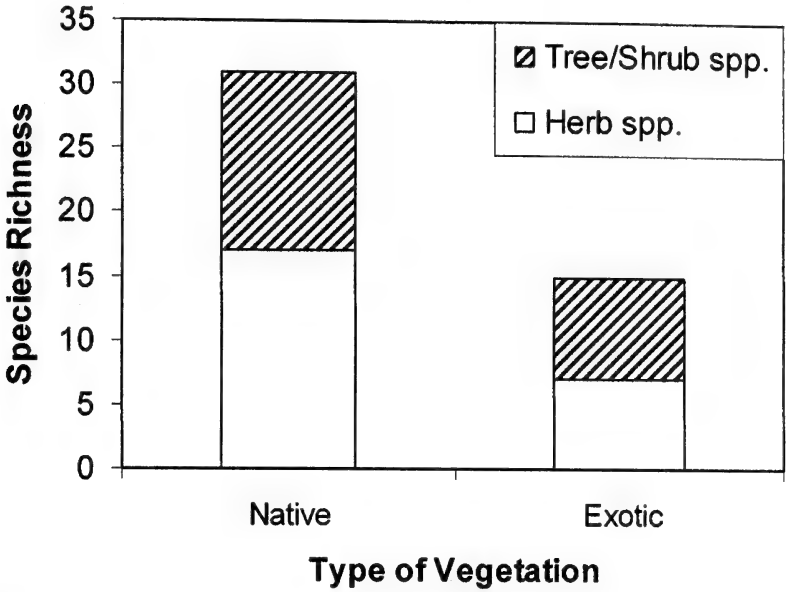

FIGURE 2.

(Fig. 2). Of the native species detected, 17 were herbaceous and 14 were tree and shrub species. Of the exotic species recorded, seven were herbaceous and eight were tree and shrub species.

Because Point au Sauble is a prominent peninsula in Green Bay and is subject to direct wave action, it is possible that seeds of invasive/exotic species transferred by water may end up settling and colonizing on Point au Sauble. This may explain why almost one third of all plant species recorded at Point au Sauble were invasive/exotic species. Another source of seeds of invasive/exotic species might be from migratory birds that may transport seeds to Point au Sauble during the spring and fall migrations. Although Point au Sauble is relatively undisturbed, there is a foot trail that encompasses the lagoon and is used for viewing birds and other wildlife. Therefore seeds of invasive/exotic species could also be introduced anthropogenically.

Overall, *Typha latifolia* (common cattail) and *Phragmites australis* (common reed) were the most common herbaceous species found at Point au Sauble (Appendix A). Common woody species included *Acer negundo* (boxelder), *Fraxinus pennsylvanica* (green ash), *Populus* spp. (cottonwood, aspen), *Salix* sp. (willow), and *Lonicera* ×*bella* (Bell's honeysuckle—a widely-accepted common name, despite the fact that it is an illiterate formation from the Latin adjective) (Appendix B).

T. latifolia had the highest mean percent cover per $1m^2$ (15.3%) of all species and other ground cover variables (Fig. 3). Litter and *P. australis* had the second and third highest percent cover, respectively. However, *T. latifolia*, litter and *P.*

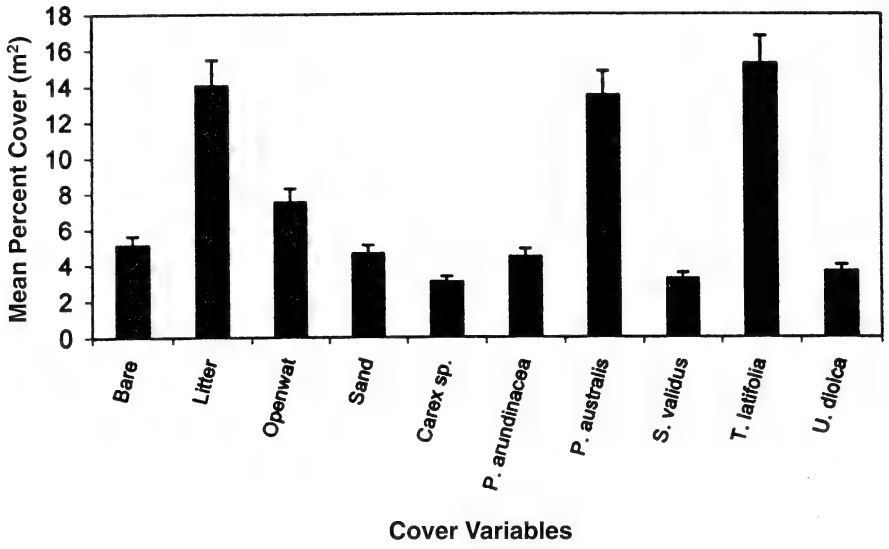

FIGURE 3.

australis did not differ significantly from each other ($P > 0.05$). *T. latifolia* was found in high abundance in high water areas in the lagoon and wet meadow habitat east of the lagoon; however, it was not found in high densities around the sandy outer banks of Point au Sauble. *P. australis* was also found in high densities in the lagoon, however unlike *T. latifolia* it was also found in high densities at sites on the edge of the waterline and beach transition zones. *P. australis* is commonly found in sandy substrates and at lower water depths compared with *T. latifolia* (personal correspondence with Gary Fewless, herbarium curator at UWGB).

Of the ten ground cover variables measured, herbaceous plants had significantly greater mean percent cover per 10 m^2 than the other measured parameters ($P < 0.0001$). Litter and sand had the next greatest percent cover with 8.14 and 8.01 percent cover, respectively. This result was not surprising since dominant habitats at Point au Sauble consist of sedge meadow, wet prairie, and forest (with herbaceous understory) communities. In addition, *T. latifolia* and *P. australis* comprised most of the herbaceous cover as illustrated in Fig. 3.

Lagoon Composition

As previously mentioned, the lagoon at Point au Sauble is connected to the bay and thus changes as Green Bay water levels fluctuate. In my study year of 2002, the Lake Michigan-Huron basin was experiencing the fourth consecutive low-water year. Before 1999, the composition of the lagoon consisted almost entirely of dense stands of *T. latifolia* (Paulios 2001). I used the cover data

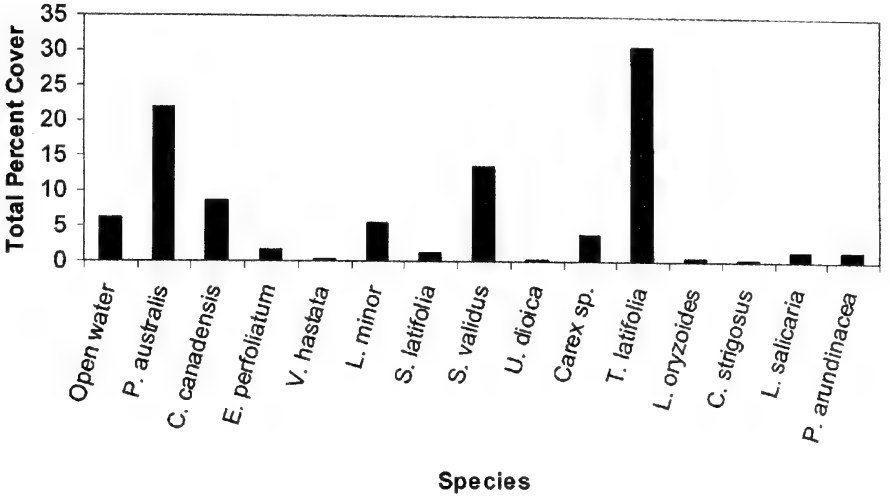

FIGURE 4.

from ten sampling points within the lagoon, to determine the vegetational composition of this wetland during a low water year (Fig. 4). *T. latifolia*, *P. australis*, and *Scirpus validus* (softstem bulrush) were the most dominant vegetation type in the lagoon. While *S. validus* was found in a few small patches, *T. latifolia* and *P. australis* were found in dense monotypic patches throughout the lagoon. For example, when *P. australis* and *T. latifolia* were detected, they were usually the only species found in any one quadrat. The several consecutive low water years have allowed *P. australis* to colonize the lagoon. Although *P. australis* was present in the lagoon before the current low water years, the higher water did not allow it to dominate the lagoon as it does currently. When average water depths return to Lake Michigan, *P. australis* may begin to die out and allow *T. latifolia* to recolonize a greater proportion of the lagoon.

CONCLUSIONS

The most dominant vegetation at Point au Sauble was *Typha latifolia* and *Phragmites australis*. These species were found in a patchy distribution around Point au Sauble, but in a much greater concentration in the lagoon area, especially P. australis. *Acer negundo* was the most dominant tree species found at Point au Sauble. Continued vegetation monitoring and possibly management are needed to reduce the number of invasive/exotic species at Point au Sauble. Continual monitoring is critical, given that the colonization of invasive/exotic species may be occurring through several pathways (birds, wild mammals, water transport, etc.). Point au Sauble continues to be an important migratory stop for passerines as well as important habitat for several mammalian species.

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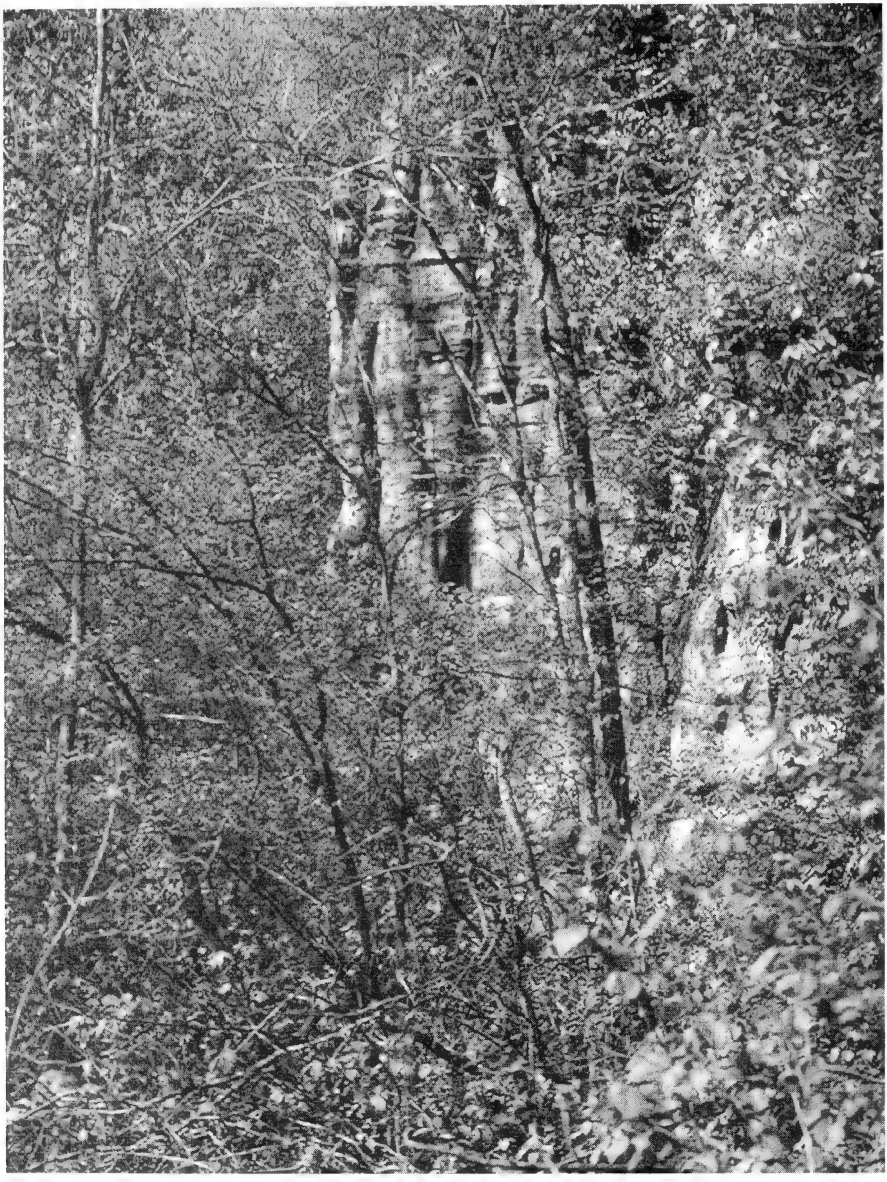
APPENDIX A. Herbaceous species list for Point au Sauble Nature Preserve.

Species
Calamagrostis canadensis (Michx) P. Beauv.
Carex spp.
Cirsium arvense (L.) Scop. *
Cyperus strigosus L.
Eupatorium perfoliatum L.
Geum spp.
Glyceria grandis S. Watson
Lactuca serriola L.
Lemna minor L.
Leonurus cardiaca L.
Lythrum salicaria L.*
Mentha arvensis L.
Phalaris arundinacea L. *
Phragmites australis (Cav.) Trin. ex Steud. *
Sagittaria latifolia Willd.
Salsola kali L.*
Saponaria officinalis L.*
Scirpus fluviatilis (Torr.) A. Gray
Scirpus validus Vahl
Solidago canadensis L.
Typha latifolia L.
Urtica dioica L.
Verbena hastata L.
Xanthium strumarium L.

* indicates exotic species.

APPENDIX B. Tree, shrub, and woody vine species list for Point au Sauble Nature Preserve. * indicates exotic species. Mean DBH (m) = mean diameter at breast height in meters, n = number of individuals, S.E. = Standard Error; the statistics are not given for woody vine species.

	Mean DBH (m)	n	S.E.
Trees			
Acer negundo L.	0.23	135	0.02
Acer platanoides L. *	0.44	1	—
Fraxinus pennsylvanica Marshall	0.67	28	0.14
Morus alba L. *	0.2	1	—
Populus balsamifera L.	0.34	12	0.07
Populus deltoides Marshall	1.50	7	0.40
Populus tremuloides Michaux	0.52	4	0.32
Prunus virginiana L.	0.12	48	0.02
Quercus macrocarpa Michaux	0.72	3	0.2
Rhamnus cathartica L. *	NA	1	NA
Salix discolor Muhl.	0.19	6	0.02
Salix fragilis L. *	0.46	20	0.09
Salix spp.	0.47	6	0.05
Ulmus pumila L. *	0.7	1	—
Shrubs			
Cornus amomum Mill.	0.07	3	0.02
Cornus racemosa Lam.	0.05	22	0.003
Cornus stolonifera Michaux	0.05	12	0.003
Lonicera ×bella Zabel *	0.06	41	0.004
Rubus occidentalis L.	NA	1	NA
Salix petiolaris J. E. Smith	0.07	16	0.01
Viburnum lentago L. *	0.05	1	—
Woody vines			
Celastrus scandens L.			
Parthenocissus inserta (Kerner) Fritsch			
Solanum dulcamara L. *			
Vitis riparia Michx.			



A spire of Cambrian-age sandstone at Honey Creek, a preserve in the Baraboo Hills of Sauk County, Wisconsin, owned by Wisconsin Society for Ornithology. Photograph by Bettie R. Harriman, May, 1994. The long trail is open to hikers all year, except during [gun] deer season in November. At the upper end of the trail is a large population of Twinleaf, *Jeffersonia diphylla* (L.) Persoon, Berberidaceae, a most uncommon species in Wisconsin, in flower in early May. Many more details may be had from a full-color 50-page booklet by Harold Kruse, "Natural Areas in the Baraboo Hills," updated, originally published in the winter of 1996–97 and reprinted February 2005. It is available from Baraboo Range Preservation Association, P.O. Box 31, North Freedom, Wisconsin 53951, in return for a donation of $25. The Association can be accessed at www.baraboorange.org, where the availability of the booklet is not mentioned.

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On the cover: Tamarack, Larix laricina (DuRoi) K. Koch, *a deciduous conifer, photographed in a bog in Marinette County, Wisconsin, by Bettie R. Harriman, September, 1998. Before the leaves fall, they turn bright yellow, which sometimes occasions comments that "All the tamaracks are dying," probably from the mistaken notion that all conifers are evergreen.*

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ANNOTATED CHECKLIST OF VASCULAR PLANTS OF NEITHERCUT WOODLAND, CLARE COUNTY, MICHIGAN

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ABSRACT

An analysis of the vascular vegetation of Neithercut Woodland, Clare County, Michigan, a 102.1 ha (252 acres) tract of land in central lower Michigan, was conducted during the growing season of 1997. The entire area was sampled using the Time Meander Procedure beginning on 3 May and ending 5 October. A list of the flora was compiled and compared to past studies. We found 257 species representing 68 plant families and 157 genera. Sixty-one species were new records for the county. A Floristic Quality Index value of 49.4 was calculated. Only one species of Special Concern was collected. An aerial photograph taken in 1994 was also used to compare the cover of the land from 1978 to the present.

INTRODUCTION

Neithercut Woodland is located in the central lower peninsula of Michigan in Surrey Township of Clare County and is owned by Central Michigan University (Fig. 1). The area comprises 102.1 ha (252.3 acres); 43.1 ha (106.5 acres) within Section 16, with the remaining 59 ha (145.8 acres) within Section 17.

Historical Significance

Clare County initially was the hunting grounds for the Chippewa Indians. Due to dense cedar swamps and giant white pines, the area was considered inhospitable, and hence there were no Indian villages. They did, however, give names to lakes and rivers, such as the Muskegon and Assemoqua. They also named the county Kay-kenee (pigeon-hawk), until it was changed by an Irish man to Clare for his own county in Ireland (Littlefield 1970).

In 1796, what was to become the state of Michigan became part of the nation as a portion of the Northwest Territory. Twenty-one years earlier, in 1775, Congress had instituted a system for surveying land, known as the U.S. Public Land Survey System. This method was used in surveying the new state of Michigan. A line running north and south down the middle of the state was established, called the Michigan Meridian, and a numbered base line running east and west was placed in the southern portion of the state, also known as eight mile road. Therefore, the surveyors' starting point was the intersection of the principal meridian and the base line. Locations were then established along both coordinates at six mile increments, resulting in a 36 square mile area, called a town-

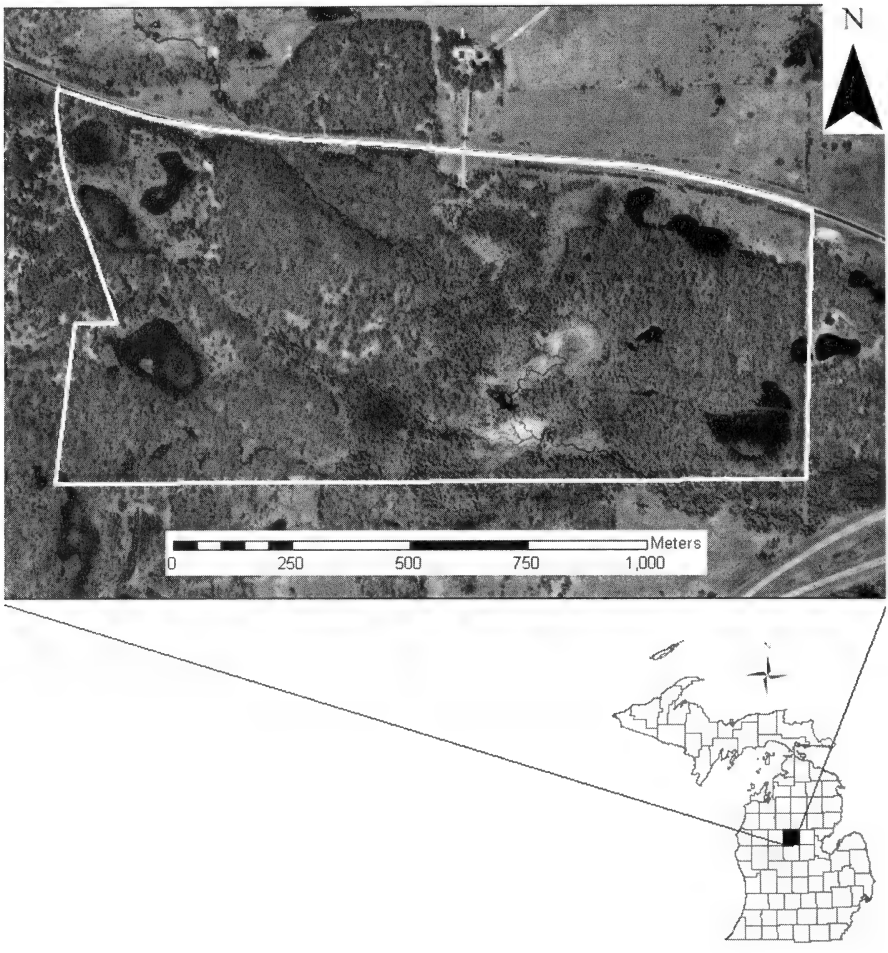

FIGURE 1. Location of Neithercut Woodland, Clare County, Michigan.

ship. In each township, sections were numbered starting in the northeast corner, resulting in 36 sections that were intended to be one square mile in area. These sections were also labeled by range east or west of the meridian, and location north or south of the baseline.

The original land surveyors who conducted this work were exceptionally trained in their field, and especially brave men. They traversed the uncharted wilderness with the essentials they needed, while carrying their surveyor's chain and compass. They accomplished all this while fighting mosquitoes in the summer and merciless snow in the winter. Their home base was originally a land office in Steubenville, Ohio, but once Michigan became a state this office was moved to Lansing. The land office was where a homesteader could pay one dollar per acre and make a claim for a piece of land (Littlefield 1970).

Originally, the majority of Michigan had been covered with primeval forest, with sixty percent of that being white pine (*Pinus strobus*). The trees were as tall as 200 feet, with 3–6 foot diameters. Astonishingly, the first branch of most of these trees was sixty to ninety feet off the ground. The white pine of Michigan was estimated to be worth billions of dollars more than the gold found in California (Littlefield 1970).

Clare County remained an untouched piece of land until the building of the Flint to Pere Marquette (Ludington) railroad in 1870. At this time, the State Legislature had passed a law to lay out some main roads throughout the state. Edmund Hall, who owned a lumber camp on the Chippewa River, was given the job to build the Ionia and Houghton Lake State Roads. The roadbeds which were constructed were 7.6 m (25') across. Considering that untamed wilderness lay before them, the construction of these roads was not an easy task. The roadbeds were built with the use of oxen and horses. In return for this hard work, Mr. Hall received large tracts of land in Isabella County and in the western part of Clare County (Littlefield 1970).

Mr. Hall's nephew, Josiah Littlefield, who was studying to be a civil engineer at the University of Michigan in Ann Arbor, Michigan, came to visit his uncle's lumber camps and seek out a direct route from the railroad to the location of a proposed town. This town was later to become known as Farwell (Littlefield 1970). This would just be the beginning of Josiah Littlefield's experience and influence on this particular area of the state. In fact, he returned to Clare Co. as a surveyor and civil engineer after finishing his degree in 1871. This job kept him busy for the next three years, as he was the only surveyor and civil engineer living in Clare at the time (Szok 1969).

In 1875, Josiah built a planing and shingle mill in Farwell, giving up his surveying job. Six years later, in 1881, he built a saw mill with a daily capacity of about 35,000 board feet. About this time, he married his second wife, and had two children, Franklin and Hazel, joining an older sister from a first marriage. Josiah bought up very large parcels of land in and around Farwell. In Surrey Township, he owned almost all of Section 6, and all of 7, 8, 9, 16, 17 and 18, including most of the land in and around the village of Farwell (Szok 1969).

Land Ownership History of Neithercut

The part of Section 16 that is now Neithercut was originally bought by Ezra Rust and James Hay of Saginaw County on 14 August 1875. James Hay died in 1885, leaving the land to his children, who in turn deeded it all to Ezra Rust for other lands. One quarter of the land was given to Charles E. Wheeler in 1886. Then, on 2 October 1900, all of section 16 was sold to Josiah Littlefield. Upon ownership by Littlefield, lumbering began (Szok 1969).

In March 1935, Josiah Littlefield died, leaving the land to his wife and three children. This same year, the Michigan Highway Department took a 45.7 m (150′) strip at the north boundary, making the right-of-way for M-115. In October of 1936, Franklin Littlefield deeded his part of the land to his sisters. Ellen Littlefield gave 2/25 of her land to Hazel Littlefield in 1937, and then in December of 1944, she gave the remainder to Hazel (Szok 1969).

The land then left the family hands, going to Lloyd and Pauline Stevens of Farwell, on 10 September 1953. Three years later, in 1956, the land was bought by Archibald W. Laughrin of Detroit. On 1 May 1961, about 122 acres lay in the hands of the Wayne County Board of Social Welfare. On 21 February 1962, it was transferred to Steve Paladin of Detroit. The final shift in ownership occurred on August 25, 1962 when the Michigan State Board of Education in Mt. Pleasant took ownership of the land. This deed excluded 2.5 acres in the northwest corner, where there is now a private residence (Szok 1969).

The first transaction referring to Section 17, was a land grant from the State of Michigan, conveying the S½ and NE ¼ as swamp land. No date was given with this transaction nor for the next. The Flint and Pere Marquette Railroad came into possession of the N ½ of the NE ½ . On 21 May 1870, Edmund Hall of Wayne County bought the S ½ of the NE ¼. The railroad land was sold to Royal C. Remick and David Whitney, Jr. on 8 June 1874. The Hall portion was bought by Royal C. Remick on 6 March 1875. William F. Naldrett of Ithaca acquired all the land previously mentioned on 1 September 1893, with the reservation that the sellers could keep all timber removed before 1 September 1893. This reservation leads to the belief that this piece of land was first timbered in the later part of 1892 or the first two-thirds of 1893. David M. Estey of Owosso became the owner the following year with the same reservation for lumber pine timber, indicating that timber-size pine did occur on the property (Szok 1969).

The land was foreclosed on 7 September 1897, due to Esty's failure to pay the mortgage. Josiah Littlefield bought the land on 29 August 1898. Upon Littlefield's death in March 1935, the family was bequeathed the land, and 45.7 m (150′) at the Northern boundary was given to the Michigan Highway Department on 7 October 1935. In October, 1936, Hazel Littlefield received all her brother's property. On 15 October 1951, the N ½ (except that north of M 115) of Section 16 owned by Hazel Littlefield Smith was conveyed to her son, Haldon Smith and his wife, Shirley Smith of Ann Arbor. All the land that was owned by the Smiths was then sold to the Michigan State Board of Education in Lansing, with Hazel Littlefield Smith selling her share on 24 February 1960 and her son and daughter-in-law, on 29 December 1959. A Central Michigan University alumnus, William Neithercut, donated the money that was used to purchase both tracts of land, hence the name of the natural area, Neithercut Woodland (Szok, 1969).

History of Lumbering

In 1900, it is known that lumber was removed from Section 16 by the Littlefields (Szok 1969). The exact date that is was removed from Section 17 itself varies according to the source. Deed transactions imply that lumber was removed late 1892 or early 1893. Franklin Littlefield in personal communication with Szok (1969), states that timber was first removed in 1898. However, in July, 1901, much of the southern portions of the forests in Section 17 and 18 were destroyed by a forest fire.

The Littlefields also owned the part of Section 17, that now lies north of highway M-115. This area was referred to as the Beechwood Farm. Upon the

commencement of lumbering, a camp called the "Littlefield Camp" or the "The Camps" was set up. There, a bunkhouse, blacksmith shop, a cookhouse and a barn for storing equipment and housing horses were built in 1901 to facilitate lumbering (Szok 1969).

The Littlefields had two main bases of operation for lumbering. One was located in sections 16 and 17 (Neithercut Area), the other in sections 8 and 9. In 1901, these were connected to the sawmill on the Farwell Mill Pond by a narrow gauge railroad (Szok 1969). The trees were loaded onto the train at the loading dock, which was located on the present site of the Wakelin McNeal Nature Center.

The first trees cut were the white pines. Hardwoods were removed in 1900, including, American beech (*Fagus grandifolia*), maple (*Acer* spp.), birch (*Betula* spp.) and hemlock (*Tsuga canadensis*). Later, such trees as basswood (*Tilia americana*), cedar (*Thuja occidentalis*), ash (*Fraxinus* spp.) and bitternut hickory (*Carya cordiformis*) were also cut (Szok 1969). According to Szok (1969), in a personal communication with Franklin Littlefield in 1963, the last maple tree was felled in 1925 and the lumber was sent to Evart to make croquette balls.

Upon visiting Neithercut, one notices open fields in the north end of Section 16, an area previously covered with hardwoods. Once the trees were cut, the stumps were removed and the area was converted to farmland (Littlefield 1964, personal communication to Szok).

Despite the fact that Josiah Littlefield was a lumberman, he also believed in conserving parts of the wilderness. He believed that future generations should be able to see what Michigan looked like during the lumbering days (Littlefield 1972). With this in mind, he left all of the northeast corner of section 17 untouched as a forest preserve. This area mostly contained American beech and maples. Sadly, in January of 1922, an ice storm hit and ruined many of the trees. All of the damaged trees there had to be removed (Smith to Szok in 1964, personal communication).

Josiah Littlefield donated thirteen acres of land to the Farewell Schools, establishing it as the first school forest in the state of Michigan. In the Detroit News for 12 October 1927, he was called the "Father of Conservation" in Clare County because of this activity and others on his property (Szok 1969).

Description of the Study Area

Neithercut Woodland is located in Clare County, in the central Lower Peninsula of Michigan. It is approximately forty-two km (twenty-six miles) northwest from the campus of Central Michigan University. The legal description for the woodland is:

All that part of the east one-half of the northeast quarter of Section Seventeen, lying south of Highway M-115, Township Seventeen North, Range Five West, of the Michigan Meridian.

MATERIALS AND METHODS

Voucher plants were collected beginning 3 May 1997, and continued through 5 October on the following sampling dates: 3, 10, 17, 18, 24, and 31 May; 1, 14, 28, and 29 June; 12 and 13 July; 2,

3, and 31 August; 1 September; and 5 October; all specimens are housed in the Central Michigan Herbarium (CMC). In order to obtain as complete an inventory as possible, each vegetational area of Neithercut was searched using the Time Meander Procedure (Goff et al. 1982).

Vascular plants were identified using appropriate field guides and reference books (Flora of North America 1993; Gleason 1952; Mickel 1979; Newcomb 1977; Voss 1972, 1985, 1996). The distribution of each plant throughout the state as well as its presence or absence in Clare County was noted using the three volumes of Voss which cover Michigan angiosperms (flowering plants) and gymnosperms. The ferns and fern allies which were collected, were not included in the distributional part of this survey, due to the lack of current Michigan distributional data.

The Floristic Quality Index (FQI) for the Neithercut Woodland was calculated following the method described in "A Floristic Quality Assessment with Wetland Categories and Computer Application Programs for the State of Michigan" (Herman et al. 1996). The above-mentioned procedure is a standardized, repeatable method of determining the floristic quality of an area of interest based upon the native plants found in that given area. Native plants have been assigned a coefficient of conservatism (C) value based on the plant's tolerance of disturbance and the fidelity it shows to presettlement-like habitats. The C values range from zero to ten, with zero being associated with the highest disturbance tolerance and least fidelity and ten being associated with the least disturbance tolerance and the greatest fidelity (Herman et al. 1996).

The property line of Neithercut was placed on a GIS computer program, Intergraph MGE, using the written description of the land and a land survey that was conducted in 1967. The GIS program used data from MIRIS (Michigan Resource Information System). In 1978, the state of Michigan began mapping the land-use and cover for the whole state, thus the name MIRIS. This was the initial information used in this study. These 1978 data were then compared to an aerial photograph of Sections 16 and 17 taken in 1994, to discern any differences or for comparisons between the two dates.

The entirety of Neithercut Woodland is 102.1 ha (252.3 acres), of which 43.1 ha (106.5 acres) lie within Section 16, with the remaining 59 ha (145.8 acres) in Section 17.

PURPOSE OF THE STUDY

A vegetational analysis was conducted on Neithercut Woodland during the growing season of 1997. A survey had been conducted in 1978 by Peter Gorton on the flora that existed 3 m (10 feet) on either side of the three trails in the Woodland; therefore, this survey intended to update that list. Our further aims were to compare aerial photographs to determine any differences between the vegetational boundaries of twenty years ago and boundaries of today; to compare the published records for Clare County plants with those observed at Neithercut; and last, because Clare County lies in the lower northern zone of the state, to compare its flora with other geographic areas of the state and especially to see if there is a difference in the vegetation at Neithercut when compared to the southern zone of the state.

RESULTS

We identified 257 species, representing 68 different plant families. Of the 68 plant families, 29 had only one representative genus. Of the 257 species, 224 were angiosperms, or flowering plants, ten were gymnosperms, and 13 pteridophytes (nine ferns, four fern allies). There were a 159 different genera. Within the angiosperms, there were 58 monocot taxa, from 10 families; there were 166 dicot taxa, from 49 families.

The largest family was the Asteraceae with 41 species. The single largest genus from the aster family was *Solidago* (Goldenrod), with six species. *Symphyotrichum* (traditional *Aster*) was also a large contributor with 5 species. Other large families included the Cyperaceae with 23 species, Poaceae (Gramineae) with 20, Rosaceae with 16, and Fabaceae (Leguminosae) and Pinaceae with nine each.

The largest genus overall was *Carex*, Cyperaceae, with 20 species. The next largest genera were *Solidago* and *Viola* with six species each, and five species each from *Pinus* and *Symphyotrichum* (traditional *Aster*).

The overall FQI value was 49.4. No state-listed endangered or threatened species were encountered in this study; one species of special concern, *Kuhnia eupatorioides* (false boneset), was observed.

DISCUSSION

Upon comparing the angiosperms and gymnosperms with their respective distributional maps in the three volumes of Voss' Michigan Flora, it was found that 46 of the Neithercut specimens were new records for the county (see annotated list, where the new records are bolded). The total number of species recorded for Clare County until this study, stood at 487 species of plants. Therefore, our additions have increased the flora of Clare County 9.4%. Most significant was the most northern occurrence of *Kuhnia eupatorioides* L. (false boneset) observed to date.

The first Neithercut floristic study was by Szok (1969); he identified 157 species from 51 plant families. These plants included angiosperms, gymnosperms, and ferns. A second study was completed in 1978 by Peter Gorton. This work included the installation of three trails through the woodland and his vegetational analysis consisted of studying the flora three meters (10') on either side of these trails. In total, he found 191 species in 57 plant families. His study also only included angiosperms, gymnosperms, and ferns as well (Gorton 1978). Therefore, the known Neithercut flora was increased by 29.3% after this new study. There were also 21 species identified by Gorton but not observed in this survey. Gorton did not make voucher specimens for his study.

When comparing the 257 species we observed with their distribution within Michigan, the majority, 229 species, can be found throughout the state. There were, however, six species that are found just in the lower peninsula of Michigan. Five species are distributed only in the southern half of the lower peninsula. Eight taxa occur only in the upper peninsula and northern half of the lower peninsula.

No Endangered or Threatened species and only one species of Special Concern, *Kuhnia eupatorioides* (false boneset), was observed. The occurrence of this taxon in Clare County represents its most northern occurrence in Michigan.

The majority of Neithercut's flora is composed of native species, although it has a marginal Floristic Quality Index (FQI) value of 49.4. A FQI value of over 50 indicates a rare community that represents a substantial component of Michi-

gan's native biodiversity (Herman et al. 1996). The low FQI value for Neithercut is due to the fact that only two species (false boneset, beechdrops) of the woodlot's 202 native plants had a C-value of 10 and less than half of the species (84) had a C-value of five or greater. The species with high C-values are less likely to be found because the tract has experienced disturbance (lumbering). Additionally, the habitats found on the Neithercut property are highly fragmented. The natural habitats are separated from each other by man-made disturbance and little, if any, by natural disturbance.

ANNOTATED LIST OF VASCULAR PLANTS

The list is arranged by major taxonomic group, then alphabetically by family, genus, and species. Nomenclature, in general, follows Voss (1972, 1985, 1996), FNA (1993), and Semple et al. (2002) for species traditionally named *Aster* but now segregated into other genera. Coefficient of Conservatism values (C) are listed to the right of each species. As asterisk indicates an adventive species (Herman et al. 1996). Species printed in **bold** are first reports for Clare County. State of Michigan status (SC = special concern) is noted to the left of the one relevant species.

PTERIDOPHYTES

LYCOPODIACEAE	
Diphasiastrum digitatum Holub (running cedar)	3
Lycopodium clavatum L. (common clubmoss)	5
Lycopodium obscurum L. (flat-branched tree clubmoss)	5
EQUISETACEAE	
Equisetum arvense L. (field horsetail)	0
DENNSTAEDTIACEAE	
Pteridium aquilinum (L.) Kuhn var. *latiusculum* (Desvaux) Underwood (bracken)	0
DRYOPTERIDACEAE	
Cystopteris bulbifera (L.) Bernhardi (bulblet bladder fern)	5
Dryopteris clintoniana (DC.) Dowell (Clinton's wood fern)	8
Dryopteris intermedia (Muhl.) A. Gray (evergreen wood fern)	8
Onoclea sensibilis L. (sensitive (fern)	2
OPHIOGLOSSACEAE	
Botrychium virginianum (L.) Swartz (rattlesnake fern)	5
OSMUNDACEAE	
Osmunda cinnamomea L. (cinnamon fern)	5
PTERIDACEAE	
Adiantum pedatum L. (northern maidenhair fern)	6
THELYPTERIDACEAE	
Thelypteris palustris Schott var. *pubescens* (Lawson) Fernald (marsh fern)	2

GYMNOSPERMS

CUPRESSACEAE
- *Thuja occidentalis* L. (eastern white-cedar) 6

PINACEAE
- *Abies balsamea* (L.) Miller (balsam fir) 3
- *Larix laricina* (DuRoi) K. Koch (tamarack) 5
- ***Picea glauca* (Moench) A. Voss** (white spruce) 3
- *Pinus banksiana* Lamb. (jack pine) 5
- *Pinus nigra* Arnott (austrian pine) *
- *Pinus resinosa* Aiton (red pine) 6
- *Pinus sylvestris* L. (scotch pine) *
- *Tsuga canadensis* (L.) Carr. (eastern hemlock) 5

MONOCOTS

ALISMATACEAE
- *Sagittaria latifolia* Willd. (Duck-potato) 1

ARACEAE
- *Arisaema triphyllum* (L.) Schott (jack-in-the-pulpit) 5
- *Symplocarpus foetidus* (L.) Nutt. (skunk cabbage) 6

CYPERACEAE
- ***Carex foenea* Willd.** (sedge) 3
- *Carex bebbii* (Bailey) Fern. (Bebb's sedge) 4
- *Carex brunnescens* (Pers.) Poiret (sedge) 5
- *Carex comosa* Boott (sedge) 5
- *Carex crinita* Lam. (sedge) 4
- *Carex cristatella* Britton (sedge) 3
- *Carex gracillima* Schw. (sedge) 4
- *Carex hystericina* Willd. (bottle sedge) 2
- *Carex interior* Bailey (sedge) 3
- *Carex intumescens* Rudge (sedge) 3
- *Carex leptonervia* Fern. (sedge) 3
- *Carex lupulina* Willd. (sedge) 4
- *Carex pedunculata* Willd. (long-stalked sedge) 5
- *Carex pseudo-cyperus* L. (cypress-like sedge) 5
- *Carex scabrata* Schw. (sedge) 4
- *Carex scoparia* Willd. (sedge) 4
- *Carex stipata* Willd. (sedge) 1
- *Carex tribuloides* Wahl. (sedge) 3
- *Carex utriculata* Boott (sedge) 5
- *Carex vulpinoidea* Michx. (sedge) 1
- *Schoenoplectus validus* (Vahl) Löve & Löve (softstem bulrush) [*Scirpus validus* Vahl] 4
- ***Scirpus atrovirens* Willd.** (bulrush) 3
- *Scirpus cyperinus* (L.) Kunth (wool-grass) 5

IRIDACEAE
- ***Iris versicolor* L.** (large blue flag) 5

JUNCACEAE
- *Juncus effusus* L. (rush) 3
- *Juncus tenuis* Willd. (path rush) 1

LEMNACEAE
- *Lemna minor* L. (duckweed) 5
- *Spirodela polyrhiza* (L.) Schleiden (greater duckweed) 6
- *Wolffia columbiana* Karsten (water-meal) 5

LILIACEAE
Maianthemum canadense Desf. (Canada mayflower) 4
Polygonatum pubescens (Willd.) Pursh. (Solomon-seal) 5
Smilacina racemosa (L.) Desf. (false solomon-seal) 5
Smilax hispida Raf. (bristly greenbriar) 5

ORCHIDACEAE
Goodyera pubescens (Willd.) R. Br. (rattlesnake plantain) 7

POACEAE
***Agrostis gigantea* Roth** (redtop) *
***Agrostis hyemalis* (Walter) BSP.** (ticklegrass) 4
***Agrostis perennans* (Walter) Tuckerman** (upland bent) 5
Andropogon gerardii Vitman (big bluestem) 5
Calamagrostis canadensis (Michx.) Beauv. (blue-joint) 3
Calamagrostis inexpansa Gray (reed grass) 8
***Cinna arundinacea* L.** (wood reedgrass) 7
***Danthonia spicata* (L.) R. & S.** (poverty grass) 4
***Glyceria striata* (Lam.) Hitchc.** (fowl manna grass) 4
***Hystrix patula* Moench** (bottlebrush grass) 5
***Leersia oryzoides* (L.) Sw.** (cut grass) 3
Oryzopsis asperifolia Michx. (rice-grass) 6
***Panicum linearifolium* Britton** (panic grass) 4
***Phalaris arundinacea* L.** (reed canary grass) 0
***Phleum pratense* L.** (timothy) *
***Poa annua* L.** (annual bluegrass) *
***Poa palustris* L.** (fowl meadow grass) 3
Poa pratensis L. (Kentucky bluegrass) *
Schizachyrium scoparium (Michx.) Nash (little bluestem) 5
Setaria glauca (L.) Beauv. (yellow foxtail) *

TYPHACEAE
***Typha latifolia* L.** (common cat-tail) 1

DICOTS

ACERACEAE
Acer rubrum L. (red maple) 1
Acer saccharum Marsh. (sugar maple) 5

ANACARDIACEAE
Rhus hirta Sudworth (staghorn sumac)
(*Rhus typhina* L. of some manuals) 2
Toxicodendron radicans (L.) Kuntze (poison-ivy) 2

APIACEAE
Cicuta bulbifera L. (bulblet water-hemlock) 5
Cryptotaenia canadensis (L.) DC. (honewort) 2
***Daucus carota* L.** (Queen Anne's lace) *
***Hydrocotyle americana* L.** (water-pennywort) 6
Osmorhiza claytonii (Michx.) C. B. Clarke (hairy sweet-cicely) 4

AQUIFOLIACEAE
Ilex verticillata (L.) A. Gray (Michigan holly) 5

ARALIACEAE
***Aralia racemosa* L.** (spikenard) 8

ASCLEPIADACEAE
Asclepias incarnata L. (swamp milkweed) 6
***Asclepias syriaca* L.** (common milkweed) 1

ASTERACEAE

	Achillea millefolium L. (yarrow)	1
	Ambrosia artemisiifolia L. (common ragweed)	0
	Antennaria neglecta Greene (pussy-toes)	2
	Bidens cernuus L. (nodding beggar-ticks)	3
	Centaurea maculosa Lam. (spotted knapweed)	*
	Chrysanthemum leucanthemum L. (ox-eye daisy)	*
	***Cirsium muticum* Michx.** (swamp thistle)	6
	Cirsium vulgare (Savi) Tenore (bull thistle)	*
	***Erigeron annuus* (L.) Pers.** (daisy fleabane)	0
	***Erigeron pulchellus* Michx.** (daisy fleabane)	5
	Erigeron strigosus Willd. (daisy fleabane)	4
	Eupatorium maculatum L. (Joe-Pye-weed)	4
	Eupatorium perfoliatum L. (boneset)	4
	Euthamia graminifolia (L.) Nutt. (grass-leaved goldenrod)	3
	Gnaphalium obtusifolium L. (fragrant cudweed)	2
	Hieracium aurantiacum L. (orange hawkweed)	*
	***Hieracium caespitosum* Dumort.** (yellow hawkweed)	*
	Hieracium scabrum Michx. (hawkweed))	3
SC	***Kuhnia eupatorioides* L.** (false boneset)	10
	Liatris aspera Michx. (blazing star)	4
	Liatris scariosa (L.) Willd. var. *novae-angliae* Lunell (northern blazing star)	5
	Matricaria matricarioides (Less.) Porter (pineapple-weed)	*
	Rudbeckia hirta L. (black-eyed susan)	1
	Solidago altissima L. (tall goldenrod)	1
	Solidago gigantea Aiton (late goldenrod)	3
	Solidago hispida Willd. (hairy goldenrod)	3
	Solidago nemoralis Aiton (gray goldenrod)	2
	Solidago rugosa Miller (rough-leaved goldenrod)	3
	Symphyotrichum lateriflorum (L.) Löve & Löve (calico aster) [***Aster lateriflorus* (L.) Britton**]	2
	Symphyotrichum novae-angliae (L). G. Nesom (New England aster) [*Aster novae-angliae* L.]	?
	Symphyotrichum ontarione (Wiegand) G. Nesom (Lake Ontario aster) [*Aster ontarionis* Wiegand]	6
	Symphyotrichum puniceum (L.) Löve & Löve (purple-stemmed aster) [*Aster puniceus* L]. (purple-stemmed aster)	5
	Symphyotrichum urophyllum (Lindl. in DC.) G. Nesom (arrow-leaved aster) [*Aster sagittifolius* Willd.]	2
	Taraxacum officinale Wiggers (common dandelion)	*
	Tragopogon dubius Scop. (goat's-beard)	*
	Xanthium strumarium L. (cocklebur)	*

BALSAMINACEAE

	Impatiens capensis Meerb. (spotted touch-me-not)	2

BERBERIDACEAE

	***Berberis thunbergii* DC.** (Japanese barberry)	*

BETULACEAE

	Alnus rugosa (Duroi) Sprengel (speckled alder)	5
	Betula alleghaniensis Britton (yellow birch)	7
	Betula papyrifera Marsh. (paper birch)	2
	Carpinus caroliniana Walter (hornbeam)	6
	Ostrya virginiana (Miller) K. Koch (ironwood)	5

BRASSICACEAE

	***Barbarea vulgaris* R. Br.** (yellow rocket)	*
	Berteroa incana (L.) DC. (hoary alyssum)	*
	Rorippa palustris (L.) Besser (yellow cress)	1

CAPRIFOLIACEAE
Sambucus canadensis L. (common elder) 3
Sambucus racemosa L. (red-berried elderberry) 3
Viburnum acerifolium L. (maple-leaved viburnum) 6
Viburnum lentago L. var. *americanum* Aiton (nannyberry) 5
***Viburnum opulus* L.** (highbush-cranberry) *

CARYOPHYLLACEAE
Cerastium fontanum Baumg. (mouse-ear chickweed) *
Dianthus armeria L. (deptford pink) *
***Stellaria longifolia* Willd.** (stitchwort) 5

CLUSIACEAE
Hypericum perforatum L. (common St. John's-wort) *

CORNACEAE
Cornus alternifolia L. (alternate-leaved dogwood) 5
Cornus canadensis L. (bunchberry) 6
Cornus racemosa Lam. (gray dogwood)
(*Cornus foemina* of some manuals) 1
Cornus sericea L. (red-osier dogwood)
(*Cornus stolonifera* Michx. of some manuals) 2

ELAEAGNACEAE
***Elaeagnus umbellata* Thunb.** (autumn-olive) *

ERICACEAE
Gaultheria procumbens L. (wintergreen) 5
Vaccinium angustifolium Aiton (low sweet blueberry) 4

FABACEAE
Lotus corniculata L. (birdfoot trefoil) *
Medicago lupulina L. (black medick) *
Melilotus alba Medicus (white sweet-clover) *
Melilotus officinalis (L.) Pallas (yellow sweet-clover) *
***Trifolium aureum* Poll.** (hop clover) *
***Trifolium hybridum* L.** (alsike clover) *
***Trifolium repens* L.** (white clover) *
Vicia villosa Roth (hairy vetch) *

FAGACEAE
Fagus grandifolia Ehrh. (American beech) 6
Quercus rubra L. (red oak) 5

GROSSULARIACEAE
Ribes americanum Miller (wild black currant) 6

HAMAMELIDACEAE
Hamamelis virginiana L. (witch-hazel) 5

JUGLANDACEAE
Carya cordiformis (Wang.) K. Koch (bitternut hickory) 5

LAMIACEAE
***Clinopodium vulgare* L.** (wild-basil) 3
Lycopus americanus W. P. C. Barton (water horehound) 2
Lycopus uniflorus Michx. (northern bugleweed) 2
***Mentha arvensis* L.** (wild mint) 3
Monarda fistulosa L. (wild-bergamot) 2
Prunella vulgaris L. (self-heal) *

MONOTROPACEAE
Monotropa uniflora L. (Indian pipe) 5

MYRICACEAE	
Comptonia peregrina (L.) Coulter (sweet-fern)	6
OLEACEAE	
Fraxinus americana L. (white ash)	5
Fraxinus nigra Marsh. (black ash)	6
Fraxinus pennsylvanica Marsh. (green ash)	2
ONAGRACEAE	
***Circaea lutetiana* L.** (enchanter's-nightshade)	2
Epilobium ciliatum Raf. (willow-herb)	3
Oenothera biennis L. (evening primrose)	2
OROBANCHACEAE	
Epifagus virginiana (L.) W. P. C. Barton (beechdrops)	10
OXALIDACEAE	
Oxalis fontana Bunge (yellow wood-sorrel)	0
***Oxalis stricta* L.** (yellow wood-sorrel)	0
PAPAVERACEAE	
Sanguinaria canadensis L. (bloodroot)	5
PLANTAGINACEAE	
Plantago lanceolata L. (English plantain)	*
Plantago major L. (common plantain)	*
POLYGALACEAE	
Polygala paucifolia Willd. (fringed polygala)	7
POLYGONACEAE	
Polygonum aviculare L. (knotweed)	*
Polygonum persicaria L. (heart's-ease)	*
Polygonum punctatum Ell. (smartweed)	5
***Rumex acetosella* L.** (sheep sorrel)	*
***Rumex crispus* L.** (curly dock)	*
PORTULACACEAE	
Claytonia caroliniana Michx. (spring-beauty)	6
Claytonia virginica L. (spring-beauty)	4
PRIMULACEAE	
Lysimachia thyrsiflora L. (tufted loosestrife)	6
Trientalis borealis Raf. (star-flower)	5
RANUNCULACEAE	
Actaea pachypoda Ell. (doll's-eyes)	7
Anemone canadensis L (Canada anemone)	4
Anemone virginiana L. (thimbleweed)	3
Ranunculus abortivus L. (small-flowered buttercup)	0
Ranunculus recurvatus Poiret (hooked crowfoot)	5
Thalictrum dioicum L. (early meadow-rue)	6
ROSACEAE	
Agrimonia gryposepala Wallr. (agrimony)	2
Amelanchier arborea (Michx.) Fern. (serviceberry)	4
Crataegus sp. (hawthorn)	-
Fragaria virginiana Miller (wild strawberry)	2
***Geum canadense* Jacq.** (avens)	1
Malus pumila Miller (apple)	*
Potentilla argentea L. (silvery cinquefoil)	*
Potentilla recta L. (rough-fruited cinquefoil)	*
Potentilla simplex Michx. (common cinquefoil)	2
Prunus pumila L. (sand cherry)	8

Prunus serotina Ehrh. (wild black cherry)	2
Rubus alleghaniensis Porter (common blackberry)	1
Rubus occidentalis L. (black raspberry)	1
Rubus pubescens Raf. (dwarf raspberry)	4
Rubus strigosus Michx. (wild red raspberry)	2
Spiraea alba DuRoi (meadowsweet)	4
RUBIACEAE	
Galium asprellum Michx. (rough bedstraw)	5
***Galium tinctorium* L.** (bedstraw)	5
Galium triflorum Michx. (sweet-scented bedstraw)	4
RUTACAE	
Zanthoxylum americanum Miller (prickly-ash)	3
SALICACEAE	
Populus balsamifera L. (balsam poplar)	2
***Populus deltoides* Marsh.** (cottonwood)	1
Populus grandidentata Michx. (largetooth aspen)	4
Populus tremuloides Michx. (quaking aspen)	1
Salix nigra Marsh. (black willow)	5
Salix petiolaris J. E. Smith (slender willow)	1
SAXIFRAGACEAE	
Chrysosplenium americanum Hooker (golden saxifrage)	6
Mitella diphylla L. (bishop's-cap)	8
SCROPHULARIACEAE	
Linaria vulgaris Miller (butter-and-eggs)	*
Verbascum thapsus L. (common mullein)	*
TILIACEAE	
Tilia americana L. (basswood)	5
ULMACEAE	
Ulmus americana L. (American elm)	1
Ulmus rubra Muhl. (slippery elm)	2
URTICACEAE	
Boehmeria cylindrica (L.) Sw. (false nettle)	5
Urtica dioica L. (stinging nettle)	1
VERBENACEAE	
Verbena hastata L. (blue vervain)	4
VIOLACEAE	
Viola blanda Willd. (sweet white violet)	5
Viola canadensis L. (Canada violet)	5
Viola conspersa Reichenb. (dog violet)	3
Viola cucullata Aiton (marsh blue violet)	5
Viola pubescens Aiton (yellow violet)	4
Viola rostrata Pursh (long-spurred violet)	6
VITACEAE	
Vitis riparia Michx. (river-bank grape)	3

ACKNOWLEDGMENTS

We thank Dr. Edward Voss for his valued input on the identification of several species and Dr. Roy Klopcic and Brad Yocum for Fig. 1. This research was funded, in part, by the Central Michigan University College of Graduate Studies. This paper is based on a thesis submitted by the first author in partial fulfillment of requirements for a M.S. degree at Central Michigan University.

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Barbara Jean Madsen led a field trip to Minden Bog in northern Sanilac County, Michigan, on Sunday, 29 May 2005. The trip was a part of the Spring 2005 Foray of the Michigan Botanical Club. Pamela Smith of Andrews University took the photograph and kindly volunteered it for this issue of the journal.

OBITUARY

With deepest regret and sympathy to her family and her many friends and admirers, we have the sad duty to report that a former editor of *The Michigan Botanist*, **Barbara Jean Madsen**, passed away at her home on 3 June 2005, at age 50.

She was born the daughter of Charles and the late Dorothy Madsen (née Loesch) in Oak Park, Illinois, on 7 September 1954. She graduated from Lyons Township High School, west of Chicago, in 1972. She then attended Carleton College, Northfield, Minnesota, where she earned a Bachelor of Arts degree in 1976, *magna cum laude*, and was also elected to Phi Beta Kappa. She then went on to attend Cambridge University, UK, after having been awarded a Winston Churchill Scholarship; this is a one-year program, given only to students of unusual distinction.

She completed her Master's degree in 1979, and her Ph.D. (Botanical Science) in 1987, both at the University of Michigan-Ann Arbor. She worked for a time at the University of Michigan field station. She enjoyed a career as an environmental consultant. In 1993, she became the Editor of *The Michigan Botanist*, beginning with 33(1) for January 1994, and ending with 37(3) for May 1998. She paid minute attention to detail and continued the distinguished tradition so ably begun by Ed Voss.

Most recently, Barbara was employed at the Cranbrook Institute of Science, Bloomfield Hills, Michigan, as a collections manager. Some of her other activities included being a member of the Academy of Early Music, whose vocal group sang at numerous churches in the Ann Arbor area. She also was an expert witness in environmental legal cases.

In her memory, memorial contributions may be made to: Director's Office, Cranbrook Institute of Science, 39221 Woodward Avenue, Bloomfield Hills, MI 48303-0801, or to the Academy of Early Music, P.O. Box 7694, Ann Arbor, MI 48107.

(Some of the details here are abstracted from an obituary that appeared in the Ann Arbor News for 12 June 2005, which may be read in its entirety at their website.)

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REVIEW

Jones, Ronald L. 2005. Plant Life of Kentucky: an illustrated guide to the vascular flora. The University Press of Kentucky. ISBN 0-8131-2331-3. Hardcover, xvi + 834 pages. $75.

You won't carry it into the field with you—too big and heavy. But it's all here: thorough keys, distributions, statements about abundance in Kentucky, and line illustrations of nearly every species. There are no descriptions of the individual species.

There are thorough essays on the geological history of the state, in addition to a primer in plant geography and an ample history of plant collecting in Kentucky. The breadth of these introductory essays may be judged by the fact that the taxonomic treatments begin on p. 107.

There are five appendices, culminating with "Index of popular books on the flora of the south-central United States and the southern Appalachians," which the author includes because he is much concerned to appeal to the amateur. The arrangement of the treatments is simply pteridophytes, gymnosperms, dicots, and monocots. Within these four categories, everything else is alphabetical. The traditional Liliaceae are reduced to the core genera (four in Kentucky), and the rest of the genera are dispersed among eleven other families. There is only one weedy *Aster* in the flora—all the rest are distributed among *Doellingeria, Eurybia, Ionactis, Oclemena, Sericocarpus,* and *Symphyotrichum.* There is even a separate "key to segregate genera of traditional Aster." The future is catching up with us.

Most of the illustrations are from the second (1913) edition of Britton & Brown; they are stiff and diagrammatic, but still very useful. There's a county outline map of Kentucky on cover 2, and an alphabetical list with page numbers of the families on cover 3.

The author includes in both the keys and the treatments quite a number of species that have not yet been found in Kentucky, but are to be expected. One of those is *Anaphalis margaritacea*, pearly everlasting. Seems to me a Great Lakes botanist ought to be able to spot that, if it's there!

"Publication of this volume was made possible in part by a grant from the National Endowment for [the] Humanities." Their website makes clear what their working definition of "humanities" is, and it certainly doesn't appear broad enough to include taxonomic botany. Nonetheless, we can join Professor Jones in saying thank you for spending some of our tax money this way. It strikes me that a work of this quality expands human horizons, which is very much a concern of the NEH.

——Neil A. Harriman
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THE BIG TREES AND SHRUBS OF MICHIGAN
44. Sassafras albidum (Nutt.) Nees
Common Sassafras

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The largest known Common Sassafras tree in Michigan is located west of Dowagiac, near Indian Lake, in Silver Creek Township, Cass County, in the southwestern part of Michigan's Lower Peninsula.

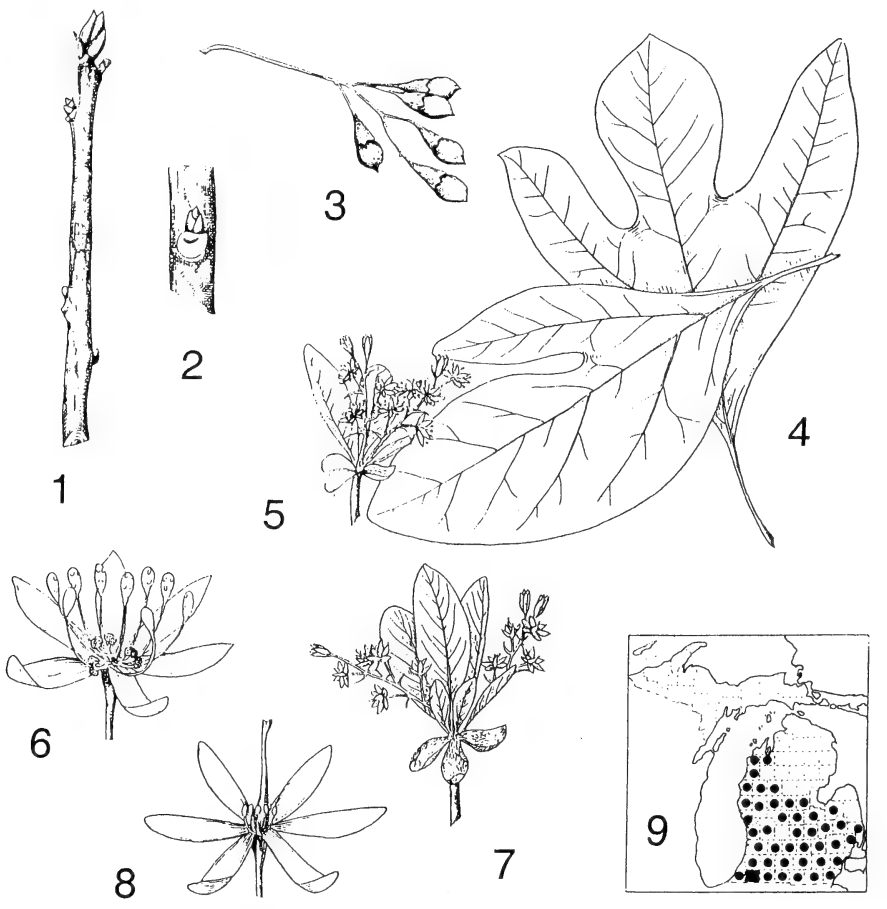
Description of the species: The Common Sassafras is a member of the Laurel Family (Lauraceae). The genus *Sassafras* is composed of three species and is one of only a few temperate genera in this largely tropical family. *Sassafras albidum* is a species of eastern North America and native to southern Michigan. Mature trees are moderate in size (6–15 m tall), with a trunk which is usually 20–60 cm in diameter (Barnes & Wagner 1981). The tree is of a roundish form. Contorted branches may spread to over 80 feet. It may be single trunked or with several trunks from the base. The trunks often sprout from roots and form extensive thickets in sandy soil. The handsome bark, dark reddish-brown and furrowed, forms flat, corky ridges.

The leaves are alternate, simple, ovate to elliptic, 3–7″ long and 2–5″ wide, with an acute or obtuse apex and a tapered, cuneate base. The leaves are bright green above and a lighter green beneath. The margins are entire, or one-lobed (mitten-shaped), or three-lobed. The medium green leaf color of summer turns to shades of yellow to deep orange to scarlet in autumn, making it one of Michigan's most spectacular natives trees for fall coloration.

The twigs are smooth, glabrous and glaucous, and bright yellow-green, sometimes reddish when exposed to direct sun. A spicy aroma is apparent when the twig is broken. Growth is from an axillary bud (sympodial), giving the branching its distinctive shape. The wood is weak, soft, and durable in soil.

The trees are dioecious; the unisexual flowers are in terminal racemes 1–2 inches long, yellow, apetalous, developing in April before the leaves, and mildly fragrant. The fruit is a dark blue drupe, ripening in September and quickly falling, or eaten by birds. The bark and roots have been used in folk culture to make sassafras tea and the "oil of sassafras" has been extracted from the roots. The oil contains the compound saffrol, which has been shown to be carcinogenic in animals studies; therefore, it can no longer be added to commercial products like root beer. Many medicinal properties have been attributed to sassafras.

Location of Michigan's Big Tree: our champion Common Sassafras is located six miles (10 km) west of Dowagiac, MI. It can be reached by taking M-62 west to Brush Lake (County Line) Road, thence north 0.6 mile (1 km) along Brush



Documented distribution and characteristics of Common Sassafras in Michigan. Cass County is shaded in. Illustrations are from Barnes and Wagner (1981). 1. Winter twig with flower bud, ×1; 2. portion of twig showing axillary bud and leaf scar, ×2; 3. autumn fruits (drupes), ×½; 4. venation and variation in leaf shape, ×½; 5. staminate (male) flowering shoot, ×½ ; 6. staminate (male) flower, with aborted ovary, ×2; 7. pistillate (female) flowering shoot, ×½ ; 8. pistillate (female) flower, with aborted stamens, ×2; 9. documented distribution of Common Sassafras in Michigan, from Voss (1985).

Lake Road to Forest Beach Road, and thence east 0.3 mile (0.5 km) on Forest Beach Road (75 yards west of Indian Trail Road that runs along the west side of Indian Lake). The tree is along the edge of Fairway #7 of the Indian Lake Hills golf course in Silver Creek Township, Cass County, T5S, R16W, section 31. The tree is in a row of other large sassafras and black cherry trees.

Description of Michigan's Big Tree: the tree has a single trunk with large branches arising ca. 10′ (3 m) above the ground. There is dead wood down the northeast side, due to an old lightning strike. The circumference of the tree at

breast height was measured on 2 June 2002 at 175″ (430 cm); the diameter is 55″ or 140 cm. The crown spread was 58′ (17.4 m). The height was measured at 60′ (18 m). This is a newly-found champion, and replaces the previous one, formerly found at 1318 Coddington Lane, Jackson, Jackson County, which has died. Another tree listed by Barnes and Wagner (1981) as a champion, this one from Berrien County, is smaller. Recent severe storms have broken several of the new champion's large upper branches. The tree can be observed by staying on the paved road and not going onto the private property of the golf course. The tree is 100+ years old. An old photograph in the golf clubhouse, taken around 1920, plainly shows the tree along the fairway. It was a large tree at that time.

INVITATION TO PARTICIPATE

If you would like to join in extending this series of articles by visiting and describing one or more of Michigan's Big Trees, please contact Elwood B. Ehrle (woodyehrle5098@sbcglobal.net) for help with the locations, specifications for taking measurements, and assistance with the manuscript. The Michigan Botanical Club encourages your involvement in this activity. Please remember to ask permission before entering private property.

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REVIEW

Welsh, Stanley L., N. Duane Atwood, Sherel Goodrich, and Larry C. Higgins. *A Utah Flora*, third edition, revised. 2003 (*post* 15 April 2003, the date on the preface.) Monte L. Bean Life Science Museum, Brigham Young University, Provo, Utah 84602; available at the museum, credit-card orders by telephone at 801. 422. 5052; $85 postpaid. Hardcover, xxii + 912 pages + endpaper map after p. 912. ISBN 0-8425-2556-4.

The first edition of this work appeared in 1987; the second edition appeared in 1993; and now we have the third edition. I am unaware of any announcement of the appearance of this book. It does not appear at amazon.com.

This edition continues all the tradition established in the two earlier editions—clearly written keys, ample descriptions, warning notes about taxonomic difficulties, and unambiguous citations of range within Utah, as well as elsewhere. In this third edition, the complete citations for places of publication of names are given; nomenclatural types are often cited, and earliest date of collection in Utah is given for many adventives. The book is printed on larger paper, so that the thickness of the third edition is less than that of the second edition.

It breaks with tradition by incorporating a goodly number of nomenclatural innovations, summarized on pp. 838–840. New species and new combinations are made throughout the text. Four new species are given fully only in these summary pages because they are extra-limital—all from McKinley County, New Mexico, well south of the Utah border. They are included here because the holotypes are deposited at BRY. One of these four is invalidly published because it does not include a Latin diagnosis or description. In order to correct this oversight, we have:

Welsh, Stanley L. 11 May 2005. Correction to an effectively but non-validly published species of *Astragalus* (Leguminosae) from New Mexico. Rhodora 107(#929): 103–104.

That paper begins, "On page page 839 of *A Utah Flora*, ed. 3 (October 1993; Monte L. Bean Life Science Museum, Brigham Young University, Provo, Utah), a name was effectively but not validly published, due to inadvertent lack of a Latin diagnosis." And that's how I found out that a third edition of 2003 existed, when I tried to unravel this mixture of duplicate words, edition number [correct], publication date [incorrect], and page number [correct].

This fine book certainly has a place in a professional library. Moreover, it is a goldmine of stray information for the interested amateur ("lover," in every best sense of that word). The authors include, with keys and descriptions, the major cultivated plants of Utah. I hadn't realized that, in order to have a truly arborescent oak tree in your yard or in a park in Utah, you have to import one from the eastern US and Canada or even Europe: white oak, swamp white oak, bur oak, northern red oak, and English oak.

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HIERACIUM LACTUCELLA WALLR. (ASTERACEAE) NEW FOR WISCONSIN.

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Hieracium lactucella Wallr. is, according to Sell & West (1976), to be found in most of Europe except the extreme north and south. The species differs from our other stoloniferous, yellow-flowered introduced hawkweeds in that it has three short-stalked capitula atop the scape (the involucres 8 mm high) and its glaucous rosette leaves are devoid of stellate hairs. The species is explicitly excluded from the flora at the plants.usda.gov website, although the basis for this is not given—it simply asserts, "Not in North America north of Mexico." The species is not mentioned at botany.wisc.edu, the website for the herbarium of the University of Wisconsin-Madison. It is mentioned in passing in Gleason & Cronquist (1991), where it is said to have been collected in the northeast part of the manual's range; however, there is no mention of it in any of the relevant, more localized floras: Catling et al. 1985; Roland & Smith 1969; Magee & Ahles 1999; Hinds 2000.

The label data are: Wisconsin, Wood County. *Hieracium lactucella* Wallr. Forming solid sods of plants, but only along a small stretch of a very lengthy (east-west) sand and muck dike on the Glacial Lake Cranberries property, west side of county trunk D, bounded on the north by state route 54, on the south by state route 173; section 29, T22N, R4E, Cranmoor Township. Basal leaves only faintly glaucous; corollas bright yellow. *Neil A. Harriman #21702 & Thomas G. Lammers*, 6 June 2003; identical locality, *Neil A. Harriman #21727 & Thomas L. Eddy*, 12 June 2003—both in OSH, duplicates to be distributed.

Both Harriman and I dug up some of the portions of the "sod" that extended into the roadway atop the dike and transplanted them into our gardens, in Winnebago and Green Lake Counties, where they continue to thrive. The glaucous state of the basal leaves is much more evident when the plants are in partial shade; in their "native site" on the dike across a cranberry bog, there was no shade at any hour of the day.

The collection site is far from any residence or garden; indeed, there are no buildings visible to the horizon. Nonetheless, the site is highly disturbed, with farm machinery and dredging equipment, and propagules of the plant may well have been brought in from some distance. The size of the population suggests that the plants have been there for some time; however, the blooming period is quite short, and the plants would be easily overlooked.

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NOTEWORTHY COLLECTIONS: MINNESOTA AND WISCONSIN

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Rumex stenophyllus Ledeb. (Polygonaceae). Narrowleaf Dock.

Previous knowledge: *Rumex stenophyllus* is a herbaceous perennial native to moist, often saline, soils from central Europe to central Asia (Löve & Bernard 1958). Its known naturalized North American range (Löve & Bernard 1958, USDA 2004) comes nearest to Wisconsin in the Twin Cities area of Minnesota (Ownbey & Morley 1991).

Significance. Two populations of *R. stenophyllus* were found in Superior, Wisconsin, apparently the first known for the state. Both included numerous individuals in tall weedy herbaceous vegetation on upland clay soil. A soil test of the Catlin site found the electrical conductivity to be 0.3 dS/m, which is a non-saline value (Lal 2002).

WISCONSIN. DOUGLAS CO.: W of Catlin Ave., at ca. 2400 block, Superior, SE ¼ Sec. 23, T49N R14W, 27 Jul 2003, *Schimpf 343* (DUL, SUWS, WIS); former petroleum tank farm, Superior, SE ¼ Sec. 16, T49N R14W, 27 Jul 2003, *Schimpf 344* (WIS).

Acer platanoides L. (Aceraceae). Norway Maple.

Previous knowledge. *Acer platanoides* is a shade-tolerant, deciduous tree native to Europe and cultivated in North America (Gleason & Cronquist 1991). It is escaped or naturalized in states east of Minnesota or in the Pacific Northwest (USDA 2004), as well as in eastern Canada (Scoggan 1978). Although shown as occurring outside of cultivation in Minnesota by USDA (2004), wild Minnesota specimens of *A. platanoides* were not found in the collections at DUL or MIN previous to this work.

Significance. *Acer platanoides* individuals over a full range of sizes were found in wooded public land along Chester Creek, Duluth, Minnesota. This may be evidence of naturalization in Minnesota, although cultivated seed sources remain nearby. A search of the similar ravine of Tischer Creek, about 2.5 km to the NE, found no wild *A. platanoides* there.

MINNESOTA. ST. LOUIS CO.: large fruiting tree below 4th St. bridge, Duluth, NW ¼ Sec. 23, T50N R14W, 30 Aug 2003, *Schimpf 346* (DUL, MIN).

Sedum spurium Bieb. (Crassulaceae). Two-row Stonecrop.

Previous knowledge. *Sedum spurium* is a mat-forming herbaceous succulent perennial native to the Caucasus Mountains (Clausen 1975). It is widely cultivated, and among the 10 alien *Sedum* species regarded by Clausen (1975) as being somewhat well naturalized in North America. Records for three counties in Michigan (Voss 1985) appear to be the known escapes or naturalizations nearest to Minnesota.

Significance. *Sedum spurium* was found on two rock outcrops in Duluth, Minnesota, apparently the first record outside of cultivation for the state. These are gently sloping basalts, covering several square meters, that receive runoff and seepage from soil. The outcrops are about 50 m apart, each surrounded by shrubby or tall herbaceous vegetation on three sides and an alley on the lower side. We infer that *S. spurium* may have been deliberately introduced there, because there were other non-native *Sedum* species on one of the outcrops (see below), but the outcrops did not abut maintained grounds or appear to have received recent caretaking.

MINNESOTA. ST. LOUIS CO.: above alley between 6th St. & 7th St., NE of 20th Ave. E, Duluth, SE ¼ SW ¼ Sec. 14, T50N R14W, 8 Jul 2001, *Schimpf 314* (DUL, MIN).

Sedum reflexum L. (Crassulaceae). Jenny's Stonecrop.

Previous knowledge. *Sedum reflexum* is a rhizomatous herbaceous succulent perennial native from Europe to North Africa (Clausen 1975). It is widely cultivated, and among the 10 alien *Sedum* species regarded by Clausen (1975) as being somewhat well naturalized in North America. This species seems not to have been reported outside of cultivation in Michigan, Minnesota, or Wisconsin (USDA 2004), or in Canada near Minnesota (Scoggan 1978).

Significance. *Sedum reflexum* was found on a rock outcrop in Duluth, Minnesota, apparently the first record outside of cultivation for the state. It was found on the southwestern outcrop of the two described above for *S. spurium*, less abundant than the *S. spurium* or *Sedum kamtschaticum* Fischer & Meyer that also grew there but flowering more freely than either of these other species. Its co-occurrence with these other *Sedum* species grown for ornament suggests that it may have been deliberately introduced to the site, but it does not appear to be actively maintained.

MINNESOTA. ST. LOUIS CO.: above alley between 6th St. & 7th St., NE of 20th Ave. E, Duluth, SE ¼ SW ¼ Sec. 14, T50N R14W, 8 Jul 2001, *Schimpf 315* (DUL, MIN).

Echinops exaltatus Schrader (Asteraceae). Tall Globe-thistle.

Previous knowledge. *Echinops exaltatus* is a herbaceous perennial native to Siberia (Scoggan 1979); it has rarely been reported as growing in North America outside of cultivation for ornament (Scoggan 1979, USDA 2004), but this may stem in part from misidentification as *E. sphaerocephalus* L. (Bailey 1949). *Echinops sphaerocephalus* may be distinguished by the presence of glandular

hairs on its herbage (Bailey 1949, Gleason & Cronquist 1991), which *E. exaltatus* lacks. Although USDA (2004) shows *E. sphaerocephalus* as recorded from Minnesota, no within-state collections of either that species or *E. exaltatus* were held by DUL or MIN previous to this discovery.

Significance. A population of about 150 flowering individuals of *E. exaltatus*, up to 2 m tall, was found in tall perennial herbaceous upland vegetation just north of Duluth, Minnesota, apparently the first record outside of cultivation for the state. There were also non-flowering individuals, including small ones that appeared to have established on disturbed ground recently. Proximity to other perennials cultivated for ornament suggested that the species had escaped from an abandoned garden and was continuing to spread slowly.

MINNESOTA. ST. LOUIS CO.: Rice Lake Township, SE ¼ SE ¼ Sec. 25, T51N R14W, not yet in flower, 18 Aug 2004, *Schimpf 381* (DUL, MIN); same location, in flower, 27 Aug 2004, *Schimpf 389* (DUL, MIN).

Digitalis grandiflora Miller (Scrophulariaceae or Plantaginaceae in some recent classifications). Large Yellow Foxglove.

Previous knowledge. *Digitalis grandiflora* is a biennial or perennial native to Eurasia, documented outside of cultivation in the northern Great Lakes in two counties in upper Michigan and in Duluth, Minnesota (Walton & Schimpf 1999). The Minnesota population was noted to be small (Walton & Schimpf 1999).

Significance. A 1978 collection made north of Hoyt Lakes, Minnesota, was determined at that time as *Digitalis lanata* Ehrh., but recently annotated by Pomroy as *D. grandiflora*. It is labeled as uncommon in a roadside ditch. In 2004 *D. grandiflora* was found at the same location to have 800–1000 flowering stems scattered across a few hectares, in upland boreal forest as well as in roadside ditches. Because these attractive plants may be hazardous to cardiac health (Walton & Schimpf 1999), this demonstration of extensive population growth and spread should be more widely known.

MINNESOTA. ST. LOUIS CO.: along both sides of highway 666 between Hoyt Lakes and mine, NW ¼ SE ¼ Sec. 20, T59N R14W, 2 Jul 1978, *Evers 71* (DUL); same location, 23 Jul 2004, *Pomroy & Barnes 1992* (MIN); *Pomroy & Barnes 1993* (DUL).

Geranium sanguineum L. (Geraniaceae). Bloody Cranesbill.

Previous knowledge. *Geranium sanguineum* is a rhizomatous herbaceous perennial native to Europe (Shishkin 1949) that was introduced to North America for ornamental cultivation. It is known outside of cultivation in several northeastern states, with the collection site closest to Minnesota being in the upper peninsula of Michigan (USDA 2004). A 1981 collection from just north of Duluth, Minnesota was labeled as rare in turf; this has been the only known specimen for the state.

Significance. The 1981 site for *G. sanguineum* was re-visited. It was found to have several dense colonies roughly 1 m in diameter each, plus a few small flowering colonies in short herbaceous vegetation and small non-flowering individuals where soil had been disturbed recently, both within a few meters of the large

colonies. The species seems to have spread on this upland setting since 1981, but not a long distance. Although the petals are described in most standard references as blood-red, reddish purple, magenta, crimson, or less commonly pink to white, the plants collected in 2004 had corollas that are on the blue side of purple, within the color range described by Bailey (1949); flowers of this species in local gardens had a similar bluish cast.

MINNESOTA. ST. LOUIS CO.: Rice Lake Township, SE ¼ SE ¼ Sec. 25, T51N R14W, 3 Jul 1981, *Farrell 44* (DUL); same location, 1 Jul 2004, *Schimpf 364* (DUL, MIN).

Cotoneaster acutifolius Turcz. var. *lucidus* (Schldl.) L. T. Lu (Rosaceae). Shiny Cotoneaster.

Previous knowledge. *Cotoneaster acutifolius* var. *lucidus* is a deciduous shrub native to portions of China and Russia, often on rocky slopes (Lu & Brauch 2003). It is introduced to North America for ornamental cultivation. The collection sites from outside of cultivation that are closest to Minnesota are in southeastern Wisconsin (Wisflora 2005) and southern Manitoba (Scoggan 1978).

Significance. A single plant, fruiting abundantly, was found in Duluth, Minnesota, apparently the first collection from outside of cultivation in the state. It was growing in thin soil atop a large mass of rough concrete, exposed to full sun, on the former site of a steel mill and cement manufacturer.

MINNESOTA. ST. LOUIS CO.: shrub 1.5 m tall near base of abandoned industrial spur into St. Louis River, Duluth, SW ¼ NE ¼ Sec. 35, T49N R15W, fruit not ripe, 4 Aug 2004, *Schimpf 378* (DUL, MIN); same location, ripe fruit black and non-glaucous, 1 Sep 2004, *Schimpf 386* (DUL, MIN).

Ammophila breviligulata Fernald (Poaceae). American Beachgrass.

Previous knowledge. *Ammophila breviligulata* is a strongly rhizomatous perennial native to the sandy shores of the Great Lakes, St. Lawrence River valley, and Atlantic coast from Newfoundland to North Carolina (Maun & Baye 1989). Introduced populations seem to persist or spread on seacoasts from South Carolina to Florida and from Vancouver Island to California (Maun & Baye 1989; Page 2001).

Significance. A collection from northwestern Wisconsin appears to be the first in the state from a deliberate planting that has shown long persistence on a non-coastal site. Undocumented information from the Wisconsin Department of Transportation (K. Sikkila, personal communication) asserts that the plantings were made in the 1970s with culms obtained from coastal New England. The two stands are large, dense, and seem vegetatively vigorous on the soft beach-like sand, but produce few flowering culms. Flowering began weeks later than it did in the nearest native populations along Lake Superior. Other species seldom occur within these stands. *Ammophila breviligulata* does not appear to be invading adjacent vegetation. The site is in an area indicated to experience the coldest winter temperatures in the state, an average annual minimum as low as –40°C (U. S. Agricultural Research Service 1990). That map suggests that this is more severe than in any other part of the known range,

with the probable exception of Lake St. John, Quebec, where the species is native (Maun & Baye 1989).

WISCONSIN. DOUGLAS CO.: Wascott Township, both sides of southbound lanes of U. S. highway 53, SE ¼ Sec. 13, T43N R12W, 28 Aug 2004, *Schimpf 385* (DUL, SUWS, UTC, UWSP, WIS).

Polygonum ×bohemicum (Chrtek & Chrtková) Zika & Jacobson (Polygonaceae). Bohemian Knotweed.

Previous knowledge. *Polygonum ×bohemicum* is a hybrid between the east Asian giant herbs *P. cuspidatum* Siebold & Zucc. and *P. sachalinense* F. Schmidt ex Maxim. (Zika & Jacobson 2003). Zika & Jacobson (2003) state that it has generally been overlooked in North America. It has not been reported from Minnesota, but is known from southern Wisconsin (Wisflora 2005).

Significance. A previous report of *P. sachalinense* from Duluth, Minnesota (Schimpf 2003) is incorrect, and the specimens listed there are more reasonably determined as *P. ×bohemicum*. This leaves no collections of *P. sachalinense* known from Minnesota.

MINNESOTA. ST. LOUIS CO.: Duluth, SW ¼ Sec. 6, T49N R14W, 27 Aug 2000, *Schimpf 289* (DUL, MIN); Duluth, SE ¼ SW ¼ Sec. 11, T50N R14W, 2 Sep 2000, *Schimpf 291* (DUL, MIN).

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TRILLIUM RECURVATUM BECK (LILIACEAE) IN GREEN LAKE COUNTY, WISCONSIN

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Five native trilliums occur in Wisconsin: *Trillium cernuum* L., *T. flexipes* Raf, *T. grandiflorum* (Michx.) Salisb., *T. nivale* Riddell (Wisconsin threatened) and *T. recurvatum* Beck (Wisflora: Wisconsin Vascular Plant Species, 2005). Like *T. nivale, T. recurvatum* is rare statewide and listed as a "special concern" species (Wisconsin Department of Natural Resources, 2004). (*T. recurvatum* is on the state threatened species list in Michigan.) Numerous common names accompany the plant: bloody butcher, bloody noses, prairie trillium, red trillium, reflexed trillium, toadshade.

In Wisconsin *T. recurvatum* is mainly distributed in the southernmost counties that border northern Illinois, occurring in southern upland and lowland forests, mesic prairies, and oak openings (Fig. 1). Gleason and Cronquist (1991)

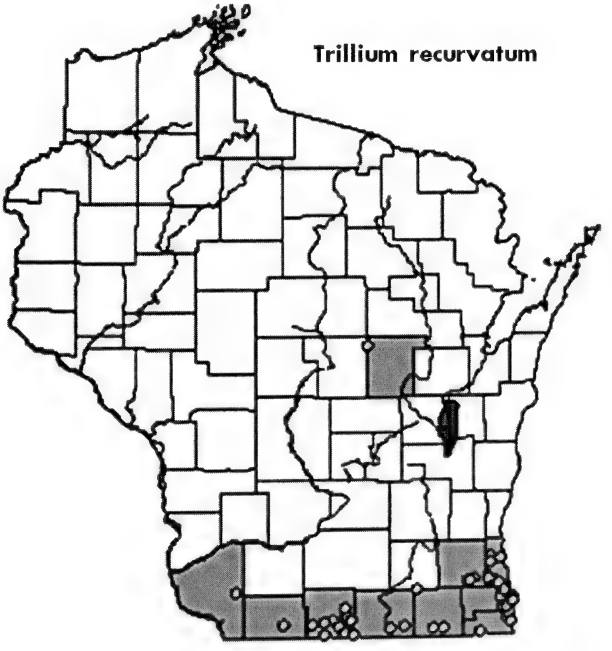

FIGURE 1. Location map for *Trillium recurvatum* in Wisconsin (Wisflora: Wisconsin Vascular Plant Species, 2005)

FIGURE 2. Note the recurved sepals in *Trillium recurvatum*. Photo by the author, 27 April 2005.

state that *T. recurvatum* ranges from western Ohio to southern Michigan, southern Wisconsin, eastern Iowa, south to Alabama, Louisiana, and eastern Texas. Case (2003) confirms this range. (It is also known from Cherokee County, Oklahoma, in the eastern part of the state—Flora of Oklahoma Project, www.biosurvey.ou.edu/floraok/, accessed 13 June 2005.)

The specific epithet, *recurvatum,* refers to the sepals that recurve downward along the stem (Fig. 2). The three whorled leaves of *T. recurvatum* are petioled and typically appear mottled (Fig. 3). In addition to seed reproduction, *T. recurvatum* reproduces by slender horizontal rhizomes. The plant flowers from April through May and unlike our other trilliums that are white flowered, *T. recurvatum* is Wisconsin's sole trillium with maroon-colored petals.

Based on the Wisconsin Floristic Quality Assessment method, *T. recurvatum* has a Coefficient of Conservatism = 6, "on a scale from 0 to 10 that represents an estimated probability that a plant species is likely to occur in a landscape relatively unaltered from what is believed to be a pre-settlement condition" and

FIGURE 3. *Trillium recurvatum* with mottled leaves. Photo by the author, 27 April 2005.

"based on that species' tolerance for disturbance and fidelity to a particular pre-settlement plant community type" (Wisflora: Wisconsin Vascular Plant Species, 2005). As a Wetland Indicator, *T. recurvatum* is ranked FACU- (Facultative Upland), meaning that its occurrence in non-wetlands is an estimated probability of 67%–99%. The negative sign indicates a frequency toward the lower end of the category, i.e. less probable in wetlands.

According to the Wisconsin Botanical Information System (Wisflora: Wisconsin Vascular Plant Species, 2005), 85 herbarium records of *T. recurvatum* are reported from 11 Wisconsin counties (Grant, Lafayette, Green, Rock, Walworth, Kenosha, Racine, Milwaukee, Waukesha, and Waupaca). Of these, the earliest collected voucher came from Racine County (v0046330WIS) on 14 May 1880, while the most recent record was collected in Rock County (UWSP128725) on 10 May 1999. One specimen, UWSP16148, not shown on the location map (Figure 1), was collected from Dane County on 15 May 1971.

Trillium recurvatum was discovered in Green Lake County on 27 April 2005 by Randal Maurer, environmental consultant with Native Solutions, Appleton, WI. A clump of three plants was observed growing on a 1.5-acre parcel within the City of Green Lake (NW ¼ NW ¼ Section 29, R13E, T16N; N43°50.227′ W88°58.350; elevation 837′) at the junction of Forest Avenue and South Lawson Street. Judging by the early land survey records and the modern-day vegetation, the original vegetation cover was oak savanna. Between sections 20 and 29, and

29 and 30, the field notes report "Land rolling second rate . . . . Scattering W. B & Bur oak" (Field notes, 1834).

The property, which was gifted to and is held in trust by the Green Lake Conservancy Foundation, Inc., is the site of an oak savanna restoration effort. In 1999 an abandoned gas station was razed and the eastern half of the property was seeded with a mixture of native grasses and forbs. In 2000, the remainder of the property (west from the old gas station) was planted with a similar mixture. There have been periodic managed burns since 1999.

It is unlikely that *T. recurvatum* was introduced by human activity at the Forest Avenue oak savanna. It is much more likely that a mature relict population survived the restoration efforts completed in 2000 or that seeds of *T. recurvatum* were present in an existing seed bank or were introduced by wildlife and germinated following the reintroduction of fire. Although *T. recurvatum* tolerates some disturbance and has been known to colonize disturbed areas (Coefficient of Conservatism = 6), it doesn't tolerate picking or overgrazing (Jones, 2003). Case and Case (1997) further clarify the point: "It is true that repeated picking of the same plant, season after season before it can manufacture enough food to maintain itself, will eventually kill *Trillium*. A far greater threat to most wild *Trillium* populations than human picking is grazing by wild or domestic animals."

Soils at the Forest Avenue oak savanna are nearly level, well-drained and classified in the Kidder-Rotamer-Grellton association. The topsoil is Grelton (GnB) fine sandy loam, with loam and loam clay subsoil, then underlain by calcareous gravel and glacial till (USDA, 1977). Albeit improbable, it is possible that seeds of *T. recurvatum* were introduced in clean topsoil that was spread and graded at the location in 1999 and 2000. It takes a trillium seed two years to produce a leaf and another six years for the plant to flower (Priestly, 2000). Thus, it is far more plausible that a population 1) was already present at the site and reemerged from rhizomes or 2) became established from an existing seed bank or was introduced by wildlife. Whatever the case, the plant apparently has benefited from periodic managed burns since 1999.

The role of fire in maintaining many fire-dependent communities should not be underestimated. Apfelbaum and Haney (1987) report that *T. recurvatum* is among those species that increased in frequency following the burning of closed-canopied woodlands at the Reed-Turner Woodland Nature Preserve, Long Grove, Lake County, Illinois. In fact, the overall response of ground cover vegetation in closed-canopied woodlands at Reed-Turner to the autumn 1986 burning involved a 10% increase in plant diversity.

T. recurvatum joins *T. grandiflorum* as the second trillium species known from Green Lake County (Eddy, 1996). It is serendipitous that this rare trillium appeared on a property being restored to oak savanna and now protected in perpetuity.

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BOOK REVIEWS

MICHIGAN TREES: A GUIDE TO THE TREES OF THE GREAT LAKES REGION, revised and updated. By Burton V. Barnes and Warren H. Wagner, Jr.† 2004. x + 448 pages. The University of Michigan Press, Ann Arbor, MI (*http://www.press.umich.edu/*). Hardcover ISBN 0-472-11352-6, $50; paperback ISBN 0-472-08921-8, $19.95.

For many years, folks in Michigan and the surrounding region have been fortunate to have a highly useful guide to their trees. The original *Michigan Trees* by Charles Herbert Otis appeared in 1913. In 1981, Burton Barnes and Herb Wagner provided a completely new version; their book has now been updated and revised for the new millennium. As with the original edition, this updating was designed to be accessible to a wide clientele, from high school students to professional foresters and ecologists. The authors have succeeded admirably in bringing the science of dendrology to a diverse array of users.

The bulk of the book is concerned with the identification of tree species. After all, if you don't know the name of the tree at hand, you're not going to learn much else about it. The format of this section makes it very easy of use, with a full two-page spread devoted to each species. On the *verso*, an extremely thorough description is provided, with a paragraph each devoted to size and form, bark, leaves, twigs, winter buds, wood, flowers, fruit (pollen cones and seed cones in the case of conifers), distribution, habitats, miscellaneous notes, chromosome numbers (if known), and a brief account of similar species not otherwise treated in the book. On the facing *recto* is a detailed drawing illustrating all major structures of the species, with a bulleted list of key characters and tips for distinguishing closely related species. The genera and families to which the species belong are also covered by introductory notes and descriptions.

Within this section, the species have been arranged so as to place related ones together. Among the angiosperms, this is accomplished by arranging the species phylogenetically. While the 1981 edition followed the classification of Cronquist (1968), the present edition embraces that of Judd et al. (2002). The most obvious expression of this change is that the families are now grouped by their orders rather than subclasses. Within the families, species are arranged alphabetically, "except where there are obvious subgeneric groups," *e.g.,* white vs. black oaks.

One *could* identify an unknown tree by simply leafing through the book, looking at the accurate line drawings and reading the comprehensive descriptions. However, it is far more efficient to use the dichotomous keys found therein. The descriptive section begins with keys to the genera, in both summer and winter condition. Each genus with multiple species is then provided with keys to its species, again in both summer and winter condition. Between the keys and the illustrated descriptions, one can make determinations of unknowns with a great degree of confidence.

But *Michigan Trees* is far more than just an identification guide. It is really a detailed exposition on the natural history and overall *biology* of trees; it could very nearly serve as a primer for the study of dendrology. The introduction to the descriptive portion is an encyclopedic and well illustrated account of tree structure (supplemented by an excellent glossary at the back of the book), explaining clearly the features elaborated under the various subheadings of the species descriptions. For example, not only are various sorts of leaf shapes and leaf margins illustrated and described, as one might ex-

pect in any identification guide. Tree-specific features such as shade vs. sun leaves and neoformed vs. late leaves likewise are explained carefully.

This explanatory section, which could easily have been very dry and business-like, contains a wealth of interesting and useful information about trees. For example, the discussion of wood characters is augmented by a section on the "Historical Importance and Uses" of various woods, while the section on size and form includes information on Michigan's "Big Tree" champions. The descriptive section also contained ample notes on pollination biology, species rare in the state, hybridization of tree species, and even why the leaves turn color in autumn. A separate section toward the end of the book (new to this edition) explains the derivation and meaning of scientific names of trees.

The section on "Ecosystems and Communities of Michigan" is an incredibly detailed account of the various factors that govern tree growth and distribution in the state: climate, geology, physiography, soils, ecological associations, human activities, etc. This section could easily serve as a stand-alone summary of the physical geography and vegetation of the state. An addition to this edition is a section entitled "Regeneration Strategies of Forest trees: Why Do Trees Grow Where They Do?" This expands on the discussion of ecosystems and communities by looking specifically at factors that govern establishment and growth of trees on a particular site.

The verdict? I cannot say it more plainly: anyone in Michigan or surrounding states who is interested in trees in any way, shape, or form must have a copy of this exemplary book. It is the single best account of tree biology in this region that I have seen.

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Barnes, Burton V. and Warren H. Wagner, Jr.† 2004. *Michigan Trees: A guide to the Trees of the Great Lakes Region, Revised and Updated.* The University of Michigan Press, Ann Arbor, MI, www.press.umich.edu. 448 pp. ISBN 0-472-08921-8. Paperback. $19.95. Cloth available for $50.00.

The botanical world lost one of its valuable members in January of 2000 when Warren H. Wagner, Jr. passed away. He was one of the two original authors of the first edition of *Michigan Trees*, published in 1981, which contained the descriptive text, keys, illustrations, and helpful information that we have all come to enjoy, and it is to Warren H. Wagner, Jr. that this edition is dedicated. The newly Revised and Updated edition, by Burton V. Barnes, has arrived on bookstore shelves, and in Internet storehouses, as another valuable book worthy of adding to both the professional and amateur library.

"It's all different, yet it's all the same." There are a number of noteworthy differ-

ences between the first edition and the present one, yet the similarities are also immediately recognized. The author has succeeded in maintaining the dual focus of this book for both professional and amateur botanists. One of the biggest differences is that the author has changed the classification system from the Cronquistian system, to the more current classification system of the Angiosperm Phylogeny Group (APG) as modified by Judd et al. in *Plant Systematics: A Phylogenetic Approach.* (The most recent APG classification can be found at: Stevens, P.F. (2001 onwards). Angiosperm Phylogeny Website. Version 5, May 2004 [and more or less continuously updated since]. http://www.mobot.org/MOBOT/research/APweb).

This classification change has had no effect on the gymnosperms, but changes like the arrangement of the angiosperms, and different family groupings may be new to readers who are not working in plant taxonomy. An example of these new changes is the elimination of the Aceraceae (Maple family) and Hippocastanaceae (Horsechestnut family), by including both in the Soapberry family, Sapindaceae.

A shift in content of this book has resulted from the decision to make *Michigan Trees* into a two-volume work. This first volume is focused on the trees of Michigan, while the shrubs and vines, that were previously included in the first edition, are going to be found in an upcoming, separate volume. Most of the species descriptions, and their accompanying illustrations, remain the same. Fourteen new species have been added to the work, making a total of 114 entries. The amount of biological information included in this edition has also greatly increased over the previous edition, including an expanded discussion on evolutionary history of gymnosperms and angiosperms, and their places both ecologically and geologically. New categories in each species description include a section of Chromosome Numbers for each species (base number, haploid, and diploid), as well as a Similar Species category, which discusses the closest relatives of each entry, whether they are found in Michigan, the western United States, or around the world.

The section titled Ecosystems and Communities of Michigan has been greatly expanded from the previous edition, while new sections entitled Fall Coloration, Hybrids, Forest Conservation, Regeneration Strategies of Forest Trees, and Derivations of Scientific Names of Trees, have been added to greatly increase the value of this book. Sixteen new figures are also included in the book, ranging from cross-sections of growth rings (which show vessel size of different angiosperm species), to variations between sun-leaf and shade-leaf morphology. Four beautiful new color plates have been added showing surficial geology features of Michigan, and presettlement vegetation. The glossary has 30+ new entries, while only a few have been omitted, and the literature cited section has more than doubled in length.

This edition is definitely an improvement over an already excellent and useful field guide/reference book. The well-protected cover of the paperback will ensure that this field guide lasts for many enjoyable years to come, for both professional and amateur botanists alike.

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ECOLOGY AND FLORISTICS OF KNIFE ISLAND, A GULL AND CORMORANT ROOKERY ON LAKE SUPERIOR, NEAR TWO HARBORS, LAKE COUNTY, MINNESOTA.

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ABSTRACT

Certain aspects of the ecology and floristics of Knife Island, near Two Harbors, Lake County, Minnesota, a small Herring Gull and Double-crested Cormorant rookery on the north shore of Lake Superior, were studied. In 1971, 63 species of vascular plants and 23 species of bryophytes were collected, including one moss newly recorded in Minnesota. In 2004, the number of vascular plants found had declined to 39. In 1971, high levels of soil organic matter and low pH levels were found. Similarly, in 2004, high levels of organic matter, with a low pH were observed. These levels appear to reflect the intensive use of the island by Herring Gulls and cormorants. Thus, it is concluded that the major factor controlling the development of vegetation on Knife Island is the Herring Gull and cormorant populations.

INTRODUCTION

Knife Island is a small, rocky island approximately 300 by 800 feet in size, located just off the north shore of Lake Superior at the Village of Knife River, near Two Harbors, Lake County, Minnesota. Geologically, Knife Island is an extension of the Stoney Point Sill Diabase (a kind of igneous rock) which extends along the north shore just south of the island, then emerges on the surface as Knife Island (Schwartz 1949; John W. Green, personal communication).

The island is of particular interest because historically it is a rookery for a large number of Herring Gulls (*Larus argentatus*) and, more recently, Double-crested Cormorants (*Phalacrocorax auritus).* The birds use the island extensively during the early summer (Minnesota DNR Colonial Bird Nest Surveys). Hofslund (1952, 1959) stated that the island supports at least 250 breeding birds per year; he banded some 500 young in one year. He further noted that most of the nests are located on bare rock on the mainland side of the island. Hofslund (personal communication) stated that the island is one of the only large gull breeding locations in the western part of the Great Lakes. In the late 1970s and early 1980s the island contained on average 250–600 active Herring Gull nests, with a high of 759 occupied nests in 1984. The cormorants were sporadically observed and not monitored until recently (Minnesota DNR Colonial Bird Nest Surveys).

In the summer of 2004 (Duluth News-Tribune, June 8) Janet Green, noted local ornithologist, observed more than 100 cormorants on Knife Island in late evening. Drilling et. al. (Minnesota DNR Colonial Bird Nest Surveys) observed

twenty-six active nests with both feathered young, and newly flying young in mid July of 2004. It was also noted that the vegetation in the vicinity of the cormorant nests on Knife Island has been destroyed as a result of their nesting (Figure 1).

Control efforts were instituted on the cormorants and thirty-eight cormorant

FIGURE 1. A dead conifer on Knife Island, Lake County, Minnesota with cormorant nests (Photograph by Derek Anderson, 4 Sep 2004). There was no vegetation growing within 3–4 meters of the tree base. The red-berried elder (Sambucus racemosa L., Caprifoliaceae) that grew nearest to this dead conifer had leaves and branches that were coated with the white excrement that "rained" down from the birds above.

nests were destroyed at the beginning of the control effort, which ran from 27 April through 26 May 2004. This is the first time the Department of Natural Resources has made any effort to control cormorants in Minnesota. It was made possible by a recent change in federal law. After the thirty-eight cormorant nests were destroyed, between twenty and thirty nests were rebuilt on the island.

There is little published information on what effect birds and their excrement have on vegetation; however, some information was found on Great Blue Heron rookeries. Fahey (1968) noted dead and dying red and white pine trees in the Great Blue Heron (*Ardea herodias*) colony at Kirk Lake, Minnesota, while Hanlon (1956) noted that shrub underbrush was killed by excrement in the Heron Island Rookery he studied, also in Minnesota. D. W. Davidson (unpublished) noted large numbers of dead red pine trees and restricted development of ground vegetation in a Great Blue Heron rookery on Basswood Lake in southern Ontario, Canada. In this rookery *Urtica dioica,* which is also found on Knife Island (Table 1), was observed to be abundant under the nests of the Great Blue Herons.

One other small island on the north shore (Beaver Island, which forms part of the Cleveland Cliffs Harbor at Silver Bay, Minnesota) has been studied by Lakela (1948). She noted birch-conifer forest developed on the island, which had a flora typical of the adjacent mainland. She also noted a Herring Gull colony on Beaver Island, but did not discuss the possible impact of nesting activities on the flora and vegetation of the island.

METHODS

The 2004 species list was compiled from the survey of Donald W. Davidson, Jessica Brandt, Derek S. Anderson, and Lynn Wright, and by the collections of small vegetative specimens. The species collected were determined by Welby Smith, Botanist, Department of Natural Resources, Ecological Services, St. Paul, Minnesota, in December of 2004. Eighteen species were determined by sight through reconnaissance by the authors. Soils were collected from two locations in the forested interior of the island and used to form a composite. The soil was analyzed by the University of Wisconsin Soil and Plant Analysis Lab, Verona, Wisconsin.

Collecting trips for this study were made in the summer of 1968 and the fall of 1969 for the 1971 paper, and a collecting trip for the 2004 paper was made on 4 September 2004. Vascular species were collected on all trips while bryophytes were collected in 1969 only. In 2004, a few bryophytes were observed on Knife Island, but none were collected, as the necessary expertise to identify them was not available. Voucher specimens of all plants cited are located in the John Thomson Herbarium at the University of Wisconsin—Superior (SUWS). Some duplicate bryophytes were deposited in the University of Minnesota Herbarium (MIN).

Conard (1956) and Crum et. al. (1965) were used for bryophyte identification in 1971. Gleason and Cronquist (1991) was used for the identification of vascular plants. National Geographic (2002) was used for the Latin nomenclature of the birds.

RESULTS AND OBSERVATIONS

There are three distinct areas on the island: 1) the gently sloping lakeside, which is essentially bare rock exposed to periodic intense wave action, 2) the mainland side, characterized by a vertical rock cliff approximately one meter

TABLE 1. Knife Island Vascular Plant List, 2004

The names, both Latin and common, follow those described in Gleason and Cronquist's Manual of Vascular Plants of Northeastern United States and Adjacent Canada, 2nd Edition.

Abies balsamea (L.) Mill.; balsam fir
Acer spicatum Lam.; mountain maple
Achillea millefolium L.; yarrow
Betula papyrifera Marsh.; paper birch, white birch
Campanula rotundifolia L.; harebell
Cerastium vulgatum L. [syn. *Cerastium fontanum* Baum. emend. Jalas]; mouse-ear chickweed
Chenopodium album L.; lamb's quarters, pigweed
Cinna latifolia (Trevir. ex Gopp.) Griseb.; drooping woodreed
Collinsonia canadensis L.; northern horse-balm, stone-root
Cornus sericea L. [syn. *Cornus stolonifera* Michx.]; red osier-dogwood
Dryopteris carthusiana (Vill.) H.P. Fuchs; toothed wood fern
Euthamia graminifolia (L.) Nutt.; common flat-topped goldenrod
Galeopsis tetrahit L.; hemp-nettle
Hordeum jubatum L.; foxtail barley
Juncus tenuis Willd.; path rush
Lonicera canadensis Marsh.; fly honeysuckle
Matricaria matricarioides (Less.) Porter; pineapple weed
Medicago lupulina L.; black medick
Phalaris arundinacea L.; reed canary grass
Picea glauca (Moench) Voss; white spruce
Plantago major L.; common plantain
Poa annua L.; speargrass
Poa compressa L.; Canada bluegrass
Polygonum arenastrum Boreau.; dooryard knotweed
Polygonum aviculare L.; knotweed
Populus tremuloides Michx.; quaking aspen
Potentilla norvegica L.; strawberry weed
Pteridium aquilinum (L.) Kuhn.; bracken fern
Ribes sp.; gooseberry
Rosa acicularis Lindl.; bristly rose
Rubus idaeus L.; red raspberry
Rubus sp.; bramble
Sambucus racemosa L. [syn *Sambucus pubens* Michx.]; red-berried elder
Sorbus americana Marsh.; American mountain-ash
Tanacetum vulgare L.; common tansy
Taraxacum officinale Weber ex Wiggers; dandelion
Taxus canadensis Marsh.; yew
Urtica dioica L.; nettle, stinging nettle
Viola sororia Willd.; dooryard violet

high at the northeast end to three meters high at the southwest end, and 3) a small forest of mountain ash (*Sorbus americana*) in the middle of the island.

The shore side and much of the small forest are modified by gull and cormorant activities. White excrement covers much of the rock surfaces, and dead birds are common in crevices (Figure 2). The white color of excrement on the rocks is readily visible from the Knife Island Harbor (nearly half a mile away). The interior of the small forest was mostly bare and trampled in 1971; in contrast, by 2004 it was a tangle of *Sambucus pubens* and was barely penetrable.

In 1971, the small forest was almost entirely mountain ash (*Sorbus ameri-*

FIGURE 2. The rocky, southeast-facing shore of Knife Island, Lake County, Minnesota, with the white bird excrement clearly visible (Photograph by Derek Anderson, 4 Sep 2004). The dominant species on the island are red-berried elder (*Sambucus racemosa* L., Caprifoliaceae) and mountain ash (*Sorbus americana* Marsh., Rosaceae).

cana), with a few paper birch (*Betula papyrifera*), and one white spruce (*Picea glauca*). Several large dead firs (*Abies balsamea*) were also observed, and an extensive growth of yew (*Taxus canadensis*) was the only undergrowth of particular importance in the forest. In 2004, the large spruce was dead, while one small sapling was found alive. A few small fir saplings were also found, and the clones of *Taxus canadensis* had decreased dramatically in size. The green alder (*Alnus crispa*) and ninebark (*Physocarpus opulifolius*), shrubs common in rocky crevices on the entire north shore, also were present on Knife Island in 1971; however, in 2004 the two species were not observed.

In 1971, 63 species of vascular plants were collected. They included six trees, twelve shrubs, thirty forbs, thirteen grasses, and two ferns (Table 2). In addition to the vascular plants, 23 species of bryophytes (Table 3) were collected. Most of the bryophyte species (11) were collected in the forest, seven on the shore side, and five on more or less exposed, bare soil. One of the species of moss, *Plagiothecium latebricola,* was new to Minnesota in 1971. It is a small, and relatively rare species, which has been reported from Newfoundland, Nova Scotia, New Jersey, Ontario, and Wisconsin. In 2004, 39 species of vascular plants were collected. They included four trees, seven shrubs, eighteen forbs, four grasses, and

TABLE 2. Knife Island Vascular Plant List, 1971

The names, both Latin and common, follow those described in Gleason and Cronquist's Manual of Vascular Plants of Northeastern United States and Adjacent Canada, 2nd Edition. The nomenclature of this list has been updated and names that were used in 1971 are included in brackets.

Abies balsamea (L.) Mill.; balsam fir
Acer spicatum Lam.; mountain maple
Achillea millefolium L.; yarrow
Actaea rubra (Ait.) Willd.; red baneberry
Agrostis gigantea Roth. [syn. *Agrostis alba* L. var. *alba*]; redtop
Alnus viridis (Vill.) Lam. [syn. *Alnus crispa* (Ait.) Pursh]; green or mountain alder
Aster ciliolatus Lindl.; northern heart-leaved aster
Aster lanceolatus Willd. [syn. *Aster simplex* Willd.]; eastern-lined aster
Beckmannia syzigachne (Steud.) Fern.; American sloughgrass
Betula papyrifera Marsh.; paper birch, white birch
Calamagrostis canadensis (Michx.) Beauv. var. *canadensis*; bluejoint
Campanula rotundifolia L.; harebell
Capsella bursa-pastoris (L.) Medic.; shepherd's purse
Cardamine pensylvanica Muhl.; Pennsylvania bitter-cress
Cinna latifolia (Trevir. ex Göpp.) Griseb.; drooping woodreed
Cirsium arvense (L.) Scop.; Canada thistle
Cirsium vulgare (Savi) Tenore; bull thistle
Clintonia borealis (Ait.) Raf.; bead lily
Cornus sericea L. [syn. *Cornus stolonifera* Michx.]; red osier-dogwood
Deschampsia caespitosa (L.) Beauv.; tufted hairgrass
Diervilla lonicera Mill.; bush honeysuckle
Dryopteris carthusiana (Vill.) H. P. Fuchs [syn. *Dryopteris spinulosa* (Mull.) Watt.]; toothed wood fern
Elymus trachycaulus (Link) Gould ex Shinners [syn. *Agropyron trachycaulum* (Link) Malte var. *glaucum* Malte]; slender wheat grass
Epilobium angustifolium L.; fireweed, great willow-herb
Erysimum cheiranthoides L.; wormseed-mustard
Galeopsis tetrahit L.; hemp-nettle
Glyceria grandis S. Watson ex A. Gray; American mannagrass
Hordeum jubatum L.; foxtail barley
Impatiens capensis Meerb.; orange touch-me-not, jewel-weed
Lonicera canadensis Marsh.; fly honeysuckle
Matricaria matricarioides (Less.) Porter; pineapple weed
Physocarpus opulifolius (L.) Maxim.; ninebark
Picea glauca (Moench) Voss; white spruce
Plantago major L.; common plantain
Poa annua L.; speargrass
Poa compressa L.; Canada bluegrass
Poa glauca Vahl.; bluegrass
Poa interior Rydb.; inland bluegrass
Poa palustris L.; fowl meadow-grass
Polygonum aviculare L.; knotweed
Polygonum cilinode Michx.; fringed bindweed
Populus tremuloides Michx.; quaking aspen
Potentilla norvegica L.; strawberry weed
Prunus pensylvanica L.; pin-cherry
Ranunculus acris L.; tall buttercup
Ribes glandulosum Grauer; skunk-currant
Ribes oxyacanthoides L.; northern gooseberry
Rorippa palustris (L.) Besser [syn. *Rorippa islandica* (Oeder) Borbas]; common yellow-cress
Rosa acicularis Lindl.; bristly rose
Rosa blanda Ait.; smooth rose

TABLE 2. (Continued)

Rubus idaeus L. [syn. *Rubus strigosus* Michx.]; red raspberry
Rubus parviflorus Nutt.; thimbleberry
Rubus setosus Bigel.; bristly blackberry
Sambucus racemosa L. [syn. *Sambucus pubens* Michx.]; red-berried elder
Sorbus americana Marsh.; American mountain-ash
Tanacetum vulgare L.; common tansy
Taxus canadensis Marsh.; yew
Trifolium repens L.; white clover
Urtica dioica L.; nettle, stinging nettle
Viola sororia Willd.; dooryard violet

two ferns (Table 1). The number of species in 2004 had declined dramatically from 1971.

In 1971, the soil was very shallow in the forest under the mountain ash trees. In 2004, the soil profiles were thicker and rich, reflecting the heavy load of bird excrement that rains down on the forest ecosystem. In 1971, the pH of the four samples taken from various locations on the island ranged from 3.6 to 4.2. Very high levels of soil organic matter, phosphate, and potassium were present (Table 4). In 2004, the soil samples came from the forest interior. The soil was also laden with a rich excrement layer. The pH was 4.1, organic matter was 50% (high), total nitrogen was high, phosphorus and potassium were very high, and calcium and magnesium were low (Table 5).

TABLE 3. Knife Island Bryophyte List, 1971; names and their authors are given in accord with the current "Index of Mosses Database," W3MOST, at the Missouri Botanical Garden website.

Amblystegium juratzkanum Schimp.
Brachythecium digastrum Müll. Hal. ex Kindb.
Brachythecium plumosum (Hedw.) Schimp.
Brachythecium reflexum (Starke) Schimp.
Brachythecium rutabulum (Hedw.) Schimp.
Bryum argenteum Hedw.
Ceratodon purpureus (Hedw.) Brid.
Funaria hygrometrica Hedw.
Grimmia alpicola Hedw. var. *rivularis* (Brid.) Wahlenb.
Haplocladium microphyllum (Hedw.) Broth.
Heterophyllium haldanianum (Grev.) M. Fleisch.
Homomallium adnatum (Hedw.) Broth.
Hygroamblystegium tenax (Hedw.) Jenn.
Hygrohypnum luridum (Hedw.) Jenn.
Leptodictyum trichopodium (Schultz) Warnst.
Leskea gracilescens Hedw.
Lophocolea heterophylla (Schrad.) Dumort.
Mnium punctatum Hedw.
Orthotrichum anomalum Hedw.
Plagiothecium latebricola Schimp.—New State Record
Pogonatum alpinum (Hedw.) Röhl.
Pohlia nutans (Hedw.) Lindb.
Pylaisia polyantha (Hedw.) Schimp.

TABLE 4. Knife Island Soil Analysis, 1971

Location	pH	Organic Matter Tons/Acre	P Pounds/Acre	K Pounds/Acre
Forest Interior	3.6	> 150	110	180
Edge of Island	4.0	> 150	400	475
Edge of Island	3.9	> 150	230	440
Open, Trampled Area	4.2	> 150	400	600

TABLE 5. Knife Island Soil Analysis, 2004

	pH	Organic Matter %	Total N%	P Pounds/ Acre	K Pounds/ Acre	Ca Pounds/ Acre	Mg Pounds Acre
Composite	4.1	50.3	1.83	298	1,748	832	218
Interpretation	Low	High	High	Very High	Very High	Low	Low

DISCUSSION

It appears that the major factor influencing the flora and vegetation of Knife Island is the Herring Gull and cormorant populations. The large number of resident birds (particularly with the arrival of the nesting cormorants), the nesting activities, the trampling of the soil and vegetation, and the large amount of excrement tend to restrict the development of several plant species.

Plants are found primarily in crevices on the shore side of the island and in the forest interior, where there is less bird activity. In 2004, the interior was nearly an impenetrable thicket of elderberry, and as the four authors walked the island searching for flora, it was very difficult to penetrate the thickets of elderberry and mountain ash without breaking many of the tree and shrub branches. Both the mountain ash and the elderberry are very robust and vigorous. The branches of elderberry are, in many cases, one inch in diameter. The mountain ash trees are quite robust and tall; many of them are over thirty feet tall. The mountain ash and elderberry are apparently doing very well as a result of the fertilizing effect of the droppings from the gulls and cormorants.

The changes in the plant cover and soils have been quite significant since Bernard et al. visited the island in 1971. Significantly fewer species are present now (39 versus 63 in 1971). In addition, there remains only one large tree on the island, mountain ash, as the large white spruce and balsam fir are dead or nearly dead. Seedlings of woody and herbaceous species are subject to damage and possible extirpation from the island.

The soil data also illustrate the profound influence of the bird populations on this island. The low pH values and the very high organic matter, phosphorus, and potassium levels probably inhibit growth of some of the plant species. The higher values of phosphorus and potassium were found where bird activity was greatest in 1971. Hofslund also noted (personal communication) that colonial

birds associated with large bodies of water are almost always nesting in areas that are not associated with heavy vegetation.

The soil samples of 2004 were taken in the late fall after gull and cormorant activity had lessened. It is possible that soil nutrient values then are lower than what would be found during nesting time, since rainfall certainly flushes nutrients off the island into Lake Superior.

Notably lacking from the flora of Knife Island were many species typical of northern forest conditions, which were found by Lakela on Beaver Island, thus confirming the idea that the flora of Knife Island is of a more "weedy" nature. Totally lacking from Knife Island were the following species found on Beaver Island, and all typical of northern coniferous forests: *Lycopodium* (five species), *Thuja occidentalis, Cornus canadensis, Polypodium virginianum, Woodsia ilvensis, Aster macrophyllus, Linnaea borealis, Vaccinium* (three species), *Pyrola* (two species), *Aralia nudicaulis, Osmunda* (two species), and *Maianthemum canadense.*

The shrub stratum on the two islands was also considerably different. On Beaver Island Lakela noted that it was "well developed." Knife Island shrubs were found to be clumped and scattered in 1971 and 2004. The herbaceous situation seemed to be similar; there is a well-developed herb stratum on Beaver Island and poor one on Knife Island. Most of the species on Knife Island, whether reported from Beaver Island or not, were weedy species from the mainland.

The conditions of the gull rookery and cormorant nesting on Knife Island are somewhat similar to those found in the rookeries of the Great Blue Heron. Trees were killed in the heron rookeries (Fahey 1968; Davidson, unpublished observations), and understory vegetation is drastically modified. However, the gulls have been documented for many decades on the island, and as a result, naturally influence the habitat in which they live, and only time will tell what further changes will occur in the flora of the island.

ACKNOWLEDGMENTS

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THE BIG TREES AND SHRUBS OF MICHIGAN
45. Juniperus virginiana L.
Eastern Redcedar

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The largest known Eastern Redcedar in Michigan is located in the Portland State Game Area, South of Portland, MI in Ionia County, in the south-central part of Michigan's Lower Peninsula (Fig. 1).

Description of the species: The Eastern Redcedar is an evergreen tree. It forms an irregular, pyramidal, columnar or pear-shaped crown (Barnes and Wagner, 1981). As a young tree it is often seen as part of old field successions and can be recognized, even at a distance, by its gray-green color. The bark on older trees is light reddish brown. It exfoliates into persistent shred-like strips. The leaves are of two types, scale-like (2 mm long) on older trees and awl or needle-like (0.6–1.3 mm. long) on younger trees. Many trees have both types. The young twigs, like the small leaves are gray-green in color. Older portions of twigs are red-brown. The male cones are small and inconspicuous. The female cones produce globose, berry-like "fruits" (Fig. 2) that are blue and glaucous.

Location of Michigan's Big Tree: The Portland State Game Area is about 20 mi NW of Lansing, MI. At the western end of Towner Road in the Portland State Game Area, there is a small parking lot. Instead of turning into the parking lot, turn left on Pohl Road and go to a small parking area on the right at 42° 49.007′N and 84° 55.843′ W. The parking lot has a red steel gate with a trail behind it. When the trail forks, take the left fork to a two-track at 42° 48.962′N and 84°55.944′ W. Take this two-track to the top of the river bank. Turn onto a deer trail at 42° 48.970′N and 84° 56.045′ W and go approximately 75 paces up-river to the tree, which sits in the woods on a bluff overlooking the Grand River. The tree is located at 42° 48.931′N and 84° 56.043′ W.

Description of Michigan's Big Tree: The State and National Champion tree has a solid, healthy trunk that disappears into the canopy of smaller deciduous trees which grow with it. The trunk has many dead branches but there are live branches near the top. The girth of the trunk was measured on 29 August 2003 at 113″, an increase of two inches from its last measurement in 1991. Since the

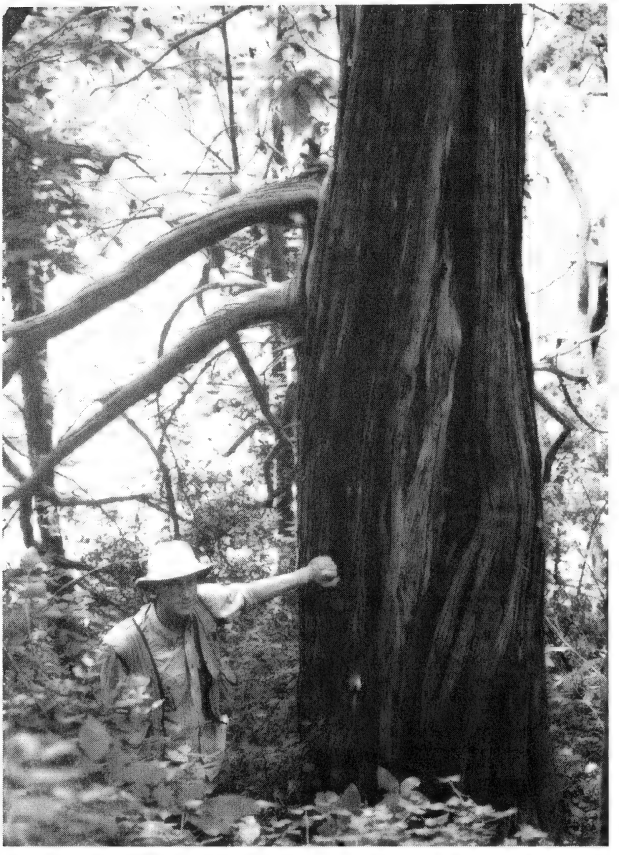

FIGURE 1: Ryan O'Connor of the Michigan Natural Features Inventory with the champion Eastern Redcedar, 17 July 2003.

top of the tree was obscured by the crowns of smaller deciduous trees and since the whole seemed quite healthy, the 1991 measurements of 66′ height and 28′ crown spread were assumed still to be correct. The total points (Girth + Height + ¼ of the Crown Spread) for this tree are therefore 113 + 66 + ¼ × 28 = 186.

Most people think of Eastern Redcedars as small, scrubby, early successional old field trees—and this is certainly the normal case. This huge individual was so much bigger (over a yard in diameter!) than the usual that it seemed to warrant some further comment, plus some information about ages and fire history to the extent the data are available.

Many "Big Trees" occur in settings where they have had opportunities to live long and grow more rapidly than usual. Often this means in fencerows, yards, and at the margins of forests. This is especially true with many smaller successional species, which are usually overtopped as the forest canopy closes and therefore attain their largest sizes only in open settings. These trees are often somewhat squat, even if they have strikingly large trunks. So it was quite startling to come across a giant individual in a forest setting on the banks of the Grand River. This tree was clearly an ancient and grizzled survivor still clinging to life, with fire scars and numerous dead limbs. Ancient trees on cliff and rock

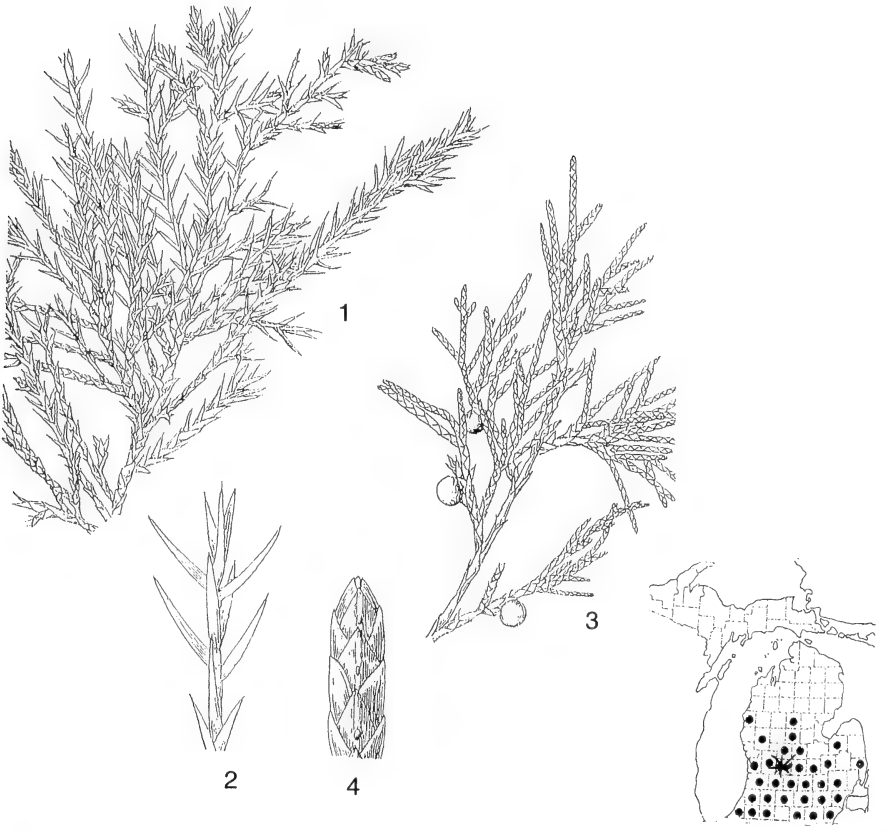

FIGURE 2. Documented distribution in Michigan and characteristics of Eastern Redcedar. Map is from Voss (1972). The asterisk indicates the location of Michigan's Big Tree. Illustrations are from Barnes and Wagner (1981). 1. Shoot with needle-shaped leaves, × 1. 2. Tip of shoot showing needle-shaped leaves, enlarged. 3. Cone-bearing shoot with needle-like leaves, × 1. 4. Tip of shoot showing scale-like leaves, enlarged.

outcrops especially have a gnarled look generated by slow growth and severe conditions, and this specimen shows this same aspect. Nevertheless, it was a magnificent forest tree, not an obese fencerow dweller.

The initial discovery of the large red cedar at Portland was made during the summer of 1988 when DA was conducting inventories for *Silene virginica* on the steep west- and south-facing slopes of the Grand River. Several large live and dead Redcedars were found growing on the steep slope, where their continued survival was assumed to be the result of open conditions resulting from both steep slope and erosion on the bluff, which was steep enough that it was difficult to walk without sliding down slope. While there were many Redcedars growing, there were several more large red cedar stumps, which appeared to have been cut many years earlier, perhaps fifty or more years ago, as there was no bark remaining on most of these stumps.

Several cores and cross-sections were removed for the sake of aging. These

dates originate from 1998, when the samples were taken. Tree core and radial section widths are given rather than diameters, as many of the tree stumps are so irregular in cross-section that an accurate diameter is hard to estimate. The oldest dead tree was from a stump 12.6 cm in radius (roughly 25 cm in diameter on one axis and 12 cm in diameter along the other) and 257 years old. This means that there were more than 20 rings per cm of growth (20.4 yrs/cm), with even slower growth characterizing the outer half of the cross-section. The growth on one axis was greater than twice that on the other. Two other living trees, both roughly 45 cm in diameter, were aged from cores, with ages of approximately 241 yrs and 264 years, indicating an establishment date very similar to that of the smaller dead tree. The growth rate on these trees averaged 12 to 13 rings per cm, greater than that for the dead tree. This difference in growth rate is typical for conifers such as white pine which are capable of surviving in low light situations.

Several other stump cross-sections were aged, including one 160 years old and 12.5 cm radius and one 91 years and 10 cm radius. Fire scars characterized both of these cross-sections, as well as several other cross-sections. One dead tree (16 cm radius), roughly 168 years old, had scars 37 years before death, 74 years before death, and 134 years before death. Another nearby tree (approximately 50 cm in diameter, with intact wood for outer 30 cm) had a similar sequence of fire scars, roughly 35 years before death and 72 years before death. Fire of natural or human origin clearly appears to have helped maintain the open conditions. The stand of large junipers appears to have become established at least 250 years ago and possibly closer to 300 or more years ago, as the oldest stump (257 years old) appears to have been cut many years ago.

No doubt, the occurrence of this giant on a southwest-facing slope down to a river helped its survival. Such a slope would stagger tree crowns and the slope and SW exposure would also allow increased lighting. Even so, the tree must have been lucky indeed to survive the past fires—clear evidence of which was seen on its trunk.

INVITATION TO PARTICIPATE

If you would like to join in extending this series of articles by visiting and describing one or more of Michigan's Big Trees, please contact Elwood B. Ehrle (woodyehrle5098@sbcglobal.net) for help with locations, specifications for taking measurements, and assistance with the manuscript. The Michigan Botanical Club encourages your involvement with this activity. Please remember to ask permission before entering private property.

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THE BIG TREES AND SHRUBS OF MICHIGAN
46. Pseudotsuga menziesii (Mirbel) Franco
Douglas-fir

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The largest known Douglas-fir tree in Michigan is located on the North Campus of the University of Michigan in Ann Arbor, MI, in Washtenaw County in the southeastern part of Michigan's Lower Peninsula.

Description of the Species: The Douglas-fir is an evergreen tree with a usually straight trunk and conical crown. The soft, flexible leaves are 2–2.5 cm long, somewhat 2-ranked, and have constricted bases. The branchlets are mostly smooth and exhibit oval scars where leaves have been removed. The cones have conspicuous three-lobed bracts extending beyond the cone scales, with the middle lobe long and narrow. This species is native to the Rocky Mountains and the North American Pacific Northwest coast, where it forms extensive forests of large trees. It is an important lumber tree in the northwest. In Michigan, it is frequently planted as a park or lawn tree and is grown as a Christmas tree which holds its needles better than Balsam Firs or Spruces. The common name honors David Douglas, 1799–1834.

Location of Michigan's Big Tree: The North Campus of the University of Michigan is located on the north side of Ann Arbor, MI. It can be reached by taking exit 180 off of I-94 and going north on Rt. 23 through Ann Arbor to Plymouth Road (exit 41). Take Plymouth Road east to Beal Road and turn right into the University of Michigan's North Campus. Go a short distance and turn left onto McIntyre Street. Follow McIntyre Street to parking lot NW23. Walk up the slope about 150′ into a grove of trees. This was formerly the site of a cemetery. The Douglas-fir stands next to a Norway Maple at 42° 17.954′ N and 83° 42.851′ W.

Description of Michigan's Big Tree: The tree has a straight solid trunk. Its girth was measured at 86″ on 23 August 2003, by Gail McPherson of Global ReLeaf of Michigan, Richard Pomorski, noted Ann Arbor area Big Tree hunter who discovered the tree, and Elwood B. Ehrle. The height was 90′ and the crown spread 40′. The total number of points (Girth +Height + ¼ of the crown spread) for this tree is, therefore, 86 + 90 + ¼ × 40 = 186.

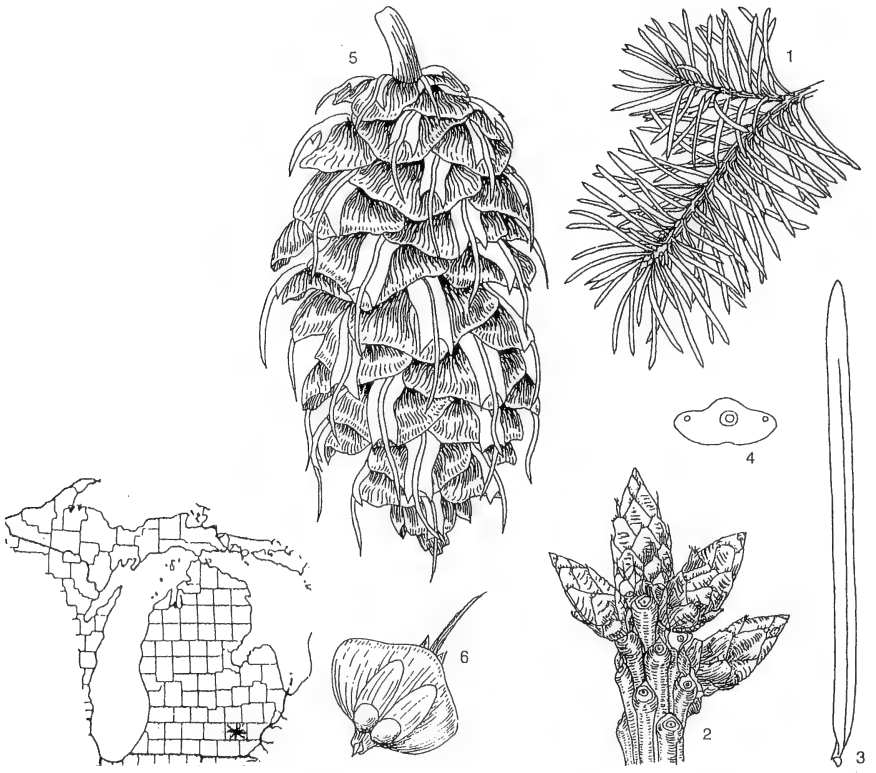

FIGURE 1. Location of Michigan's Champion tree and characteristics of Douglas-fir. The asterisk on the map indicates the location. Illustrations are from Barnes and Wagner (1981). 1. Winter shoot, ×2. 2. Winter buds (leaves removed), ×2. 3. Leaf, ×2. 4. Cross section of leaf, ×10. 5. Opened cone, ×1. 6. Cone scale with seeds, ×1.

INVITATION TO PARTICIPATE

If you would like to join in extending this series of articles by visiting and describing one or more of Michigan's Big Trees, please contact Elwood B. Ehrle (woodyehrle5098@sbcglobal.net) for help with locations, specifications for taking measurements, and assistance with the manuscript. The Michigan Botanical Club encourages your involvement with this activity. Please remember to ask permission before entering private property.

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THE BIG TREES AND SHRUBS OF MICHIGAN
47. Acer negundo L.
Box Elder or Ash-leaf Maple

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The largest known Box Elder in Michigan is located in Milan, MI, in Washtenaw County in the southeast portion of Michigan's Lower Peninsula. This is a State and National Co-Champion tree.

Description of the species: The Box Elder is the only maple in Michigan having pinnately compound, opposite leaves and the characteristic maple samara fruit (Fig. 1). Box Elders have trunks that frequently branch close to the ground. The twigs are green and have a waxy bloom. The Box Elder flowers in late April or early May just as the leaves are becoming obvious. The trees are dioecious. The samaras are quite distinctive. They are "narrow, flat and in v-shaped pairs" (Barnes & Wagner, 1981).

Location of Michigan's Big Tree: Milan, MI, is south of Ann Arbor and can be reached by taking exit 180 (Rt. 23 S) off I-94 and heading south to Carpenter St. (exit 27). Carpenter St. becomes Dexter St. in Milan. Continue south on Dexter St. to the end and turn left onto Main St. The tree is beside the driveway at 226 Main St., next to a white house with blue trim and a large porch. The coordinates for this location are 42° 04.970′ N and 83° 40.710′ W.

Description of Michigan's Big Tree: The tree has a healthy, solid, single trunk to a height of 5′. It then divides into three large branches. The girth was measured at 260″ on 23 August 2003 by Gail McPherson of Global ReLeaf of Michigan, Richard Pomorski, noted Ann Arbor area Big Tree hunter, and Elwood B. Ehrle. The height was 76′ and the average crown spread 67′. The total number of points for this tree (Girth + Height + ¼ of the crown spread) is, therefore, 260 + 76 + ¼ of 67 = 353.

There is another very large Box Elder near Milan, MI. It is the former State and National Champion tree. It can be found at Saline and Mooresville Roads northwest of Milan. It was measured at G = 214, H = 110, & C.S. = 127. The total points for this tree (G + H + ¼ of C.S.) = 356. These two trees are Co-champions in several ways The tree at Dexter and Main Sts. has a larger girth, but the tree at Saline and Mooresville Rds. is higher and has a wider crown.

FIGURE 1. Documented distribution and characteristics of the Box Elder. The map is from Voss (1985). The asterisk shows the location of the State and National Co-Champion trees. The illustration is from Barnes and Wagner (1981). 1. Winter twig, ×1. 2. Leaf, × ½. 3. Male flowering shoot, ×½. 4. Male flower, enlarged. 5. Female flowering shoot, ×½. 6. Female flower, enlarged. 7. Fruit, samara, ×1.

INVITATION TO PARTICIPATE

If you would like to join in extending this series of articles by visiting and describing one or more of Michigan's Big Trees, please contact Elwood B. Ehrle (woodyehrle5098@sbcglobal.net) for help with locations, specifications for taking measurements, and assistance with the manuscript. The Michigan Botanical Club encourages your involvement with this activity. Please remember to ask permission before entering private property.

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On the cover: *Dr. Barbara Jean Madsen explains about mosses on a Spring Foray field trip to Minden Bog, northern Sanilac County, Michigan, Sunday, 29 May 2005. Photo courtesy of Pamela Smith, Andrews University.*

May, 2005

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Articles dealing with any phase of botany relating to the Great Lakes Region may be sent to the Editor at the address above. In preparing manuscripts, authors are requested to follow our style as well as "Suggestions for contributors" on Cover 3.

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THE DISTRIBUTION OF *CHLORIS VERTICILLATA* (TUMBLE WINDMILL GRASS, POACEAE) IN OHIO

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Chloris verticillata (Tumble windmill grass, Poaceae, Fig. 1) was first described by Thomas Nuttall from material collected in Arkansas (Nuttall 1835). Its original range appears to have been in the prairies from Louisiana west to Arizona, north to Colorado and South Dakota, and south through Iowa, Missouri and Arkansas (Barkworth 2003; Great Plains Flora Association 1986). The species has spread west into Nevada and California, and east to Illinois, Indiana, Michigan, Ohio, Kentucky, Tennessee, Pennsylvania, New York, Maryland, Rhode Island, Virginia, South Carolina, Connecticut, Massachusetts, and New Jersey (Barkworth 2003; Kartesz and Meacham 1999). It has also been reported from Delaware (McAvoy 2004) and Wyoming (Wyoming Native Plant Society 1982).

Tumble windmill grass (also known as windmill grass and finger windmill grass) is a tufted perennial species growing from 10 to 40 cm tall. Its stems are erect to decumbent, often strongly jointed at the nodes, with flattened sheaths, and often rooted at the nodes. The leaves are often concentrated at the base of the stem, with flat blades ranging from 4 to 15 cm in length and 2 to 4 mm wide. Inflorescences of the species are purple to pinkish, when young consisting of upwardly pointed branches emerging from a folded leaf at the tip of the stem. As the inflorescence emerges, the branches flatten out to a verticillate arrangement of 2 to 4 or more whorls of branches, giving the species its characteristic appearance (Fig. 1a). The inflorescence measures from 15 to 28 cm in width at maturity, and up to 15 cm from the lowest whorl of branches to the upper tip. The spikelets (Fig. 1b), composed of 2 glumes and 1 fertile (lower) floret and 1 sterile (upper) floret, measure about 3 mm in length, with an awn up to 10 mm in length at the tip of each lemma. As the fruits mature, the inflorescence fades to straw-colored or slightly pink, often breaking loose from the plant and being blown around by wind.

The spread of *Chloris verticillata* from its historical range appears to have several causes. First, the species may have expanded its range naturally due to the wind-borne nature of its inflorescence, which can be blown around quite effectively by strong winds (personal observation). Secondly, the interstate highway system may play a role in its distribution, as may rail lines. The species may be weedy or invasive in at least some regions of the United States (e.g., Kansas, problem weed in lawns [Haddock 2004]; Michigan, considered a wide-spread non-native species [Michigan Association of Conservation Districts 2004]; Nebraska, considered invasive [Stubbendieck et al. 1994]; US Forest Service East-

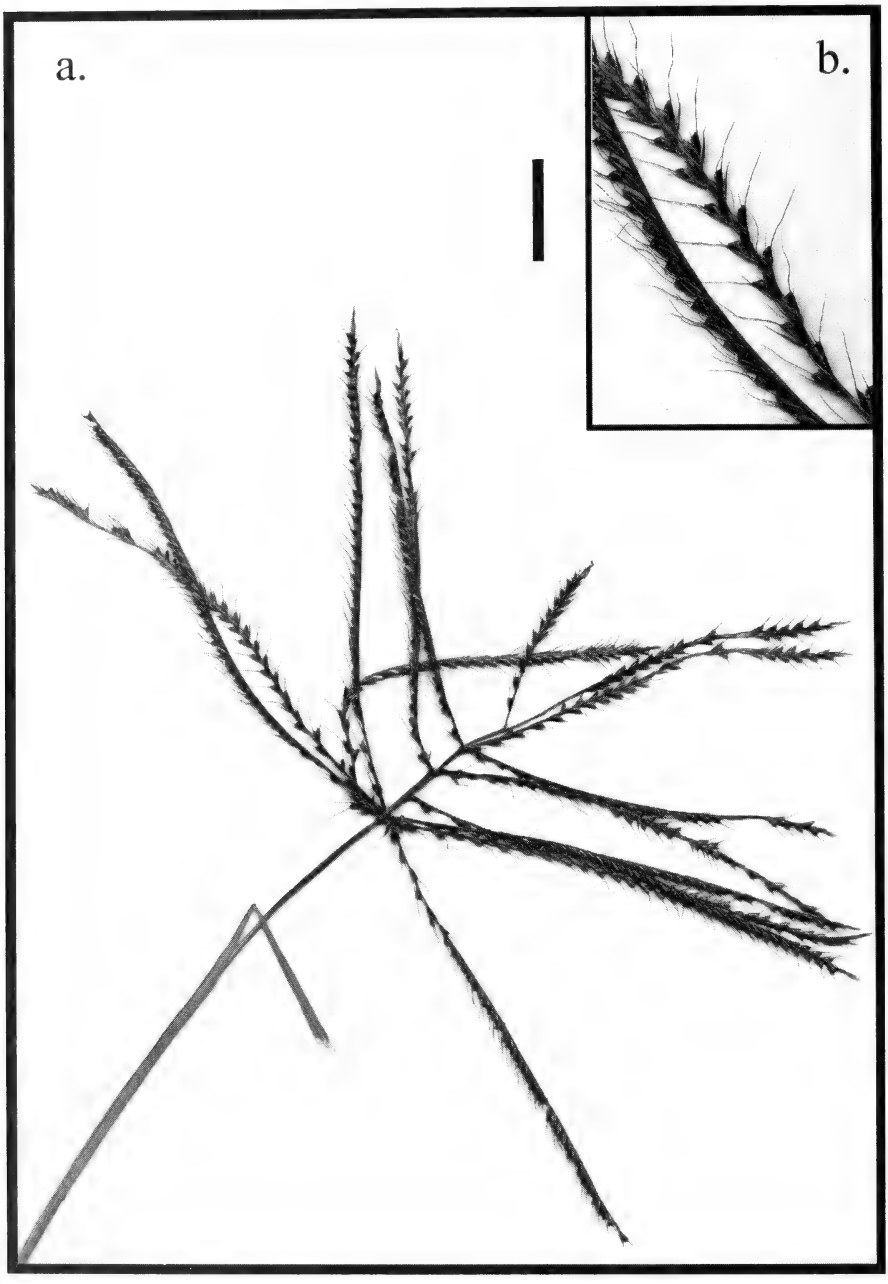

FIGURE 1. *Chloris verticillata* (*Vincent 7993*, MU). a. Inflorescence (bar = 2cm). b. Closeup of spikelets (bar = 1.3cm).

ern Region, considered a wide-spread non-native species [USFS 2005]), and is listed in a compendium of world weeds (Randall 2002). In no-till agricultural fields in its native range, tumble windmill grass can become a significant problem after a few cycles of crop rotations (Anderson 2004; Hagny 2003). It is also available through horticultural sources (e.g., Bluestem Nursery 2005), and thus may spread from cultivation. While this species of grass may be included in some lawn grass seed mixtures, I was unable to find any documentation to verify it.

The species may serve as a non-maize reservoir for Western Corn Rootworm (Wilson and Hibbard 2004). The grass is unpalatable to grazing cattle (Haddock 2004). The grass has been utilized by barn swallows as a component of nests (Whelan 2003).

Confusion abounds in the literature on the flora of Ohio regarding the presence and distribution of *Chloris verticillata* in the state. The first published report of *Chloris verticillata* in Ohio was that of Weishaupt (1985), in her key to grasses in the vegetative condition, where she lists the grass as found in three southwestern counties. The species was also included in an addendum (on page 293) in the back of the eighth printing of the third edition of Weishaupt's *Vascular Plants of Ohio* (Weishaupt 1987), and confusion about its date of publication makes it appear that the first report was for 1971, which is the date of the first printing of that edition; the actual printing date of the eighth printing of the third edition was April 1987 (Kendall-Hunt Publishing, pers. comm. 15 June 2004). While the range of the species includes Ohio in Barkworth (2003), the species is mapped for only one county in the central portion of the state. *Chloris verticillata* is also listed as present in Ohio by Kartesz and Meacham (1999). Cooperrider et al. (2001) do not list the species as part of the Ohio flora in their *Seventh Catalogue*. The species is not listed as occurring in Ohio in any of the following publications: Schaffner (1917, 1928), Hitchcock (1935), Hitchcock and Chase (1950), Fernald (1950), Pohl (1954), Weishaupt (1967), Anderson (1974), Gleason and Cronquist (1991). Indeed, in Anderson's 1974 monograph of the genus, he neither mentions nor maps any specimens east of central Iowa. It is also apparent that specimens from sites west of New Mexico and Colorado were unknown to him.

Since several Ohio populations of tumble windmill grass are known to me, I decided to investigate further and see the extent to which it occurs in the state. Specimens were examined from the following herbaria: CM, F, ISC, KE, KNK, MICH, MO, MU, OS. A total of 31 sheets of *Chloris verticillata* were examined for the study, representing 17 separate collections (see Appendix 1). Populations of the species were documented from nine Ohio counties: Butler, Clark, Franklin, Greene, Hamilton, Miami, Montgomery, Pickaway, and Sandusky. The grass was found in lawns, especially along roads and railroad tracks.

Chloris verticillata does not seem to be an invasive species in Ohio. Populations examined appeared to be relatively small and restricted. The lawns in which the species was found contained mixtures of several lawn grasses, forbs, and weeds, and were not particularly negatively impacted by the presence of the species. Indeed, the only time the grass appears anything out of the ordinary is at flowering, when the reddish inflorescences project above the leafy portions of

the plants. Since several of the populations have persisted for decades, it appears that the grass will remain a part of Ohio's weedy flora, and will perhaps spread slowly in the state.

ACKNOWLEDGMENTS

I wish to thank the following herbaria for access to or information about specimens: CM, F, ISC, KE, KNK, MICH, MO, MU, OS. Thanks to Allison W. Cusick, who provided information pertinent to the study.

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APPENDIX 1. SPECIMENS EXAMINED

OHIO. Butler County: Oxford, tree lawn on south side of Spring Street just east of the railroad tracks, 23 Aug 1997, *M. A. Vincent 7993* (F, ISC, KNK, MICH, MO, MU, OS); Oxford, vacant lot west of the railroad, Spring Street, 28 Jun 1982, *K. W. Dougherty 682-30* (MU); *ibid*, 6 Jul 1982, *K. W. Dougherty 782-01* (MU). Clark County: Springfield, grassy area, corner of Greenmont and Highland, Aug/Sep 1975, *C.G. Weishaupt s.n.* (OS). Franklin County: Columbus, lawns at Ohio Woolgrowers warehouse, 1 Sep 1986, *A. W. Cusick 25795* (KE, MICH, OS); *ibid*, 11 Sep 1986, *A. W.Cusick 25866* (CM, MU); Columbus, Greenlawn Cemetery, *A. W. Cusick 34040* (CM). Greene County: Fairborn, yard on Central Ave., Sep 1974, *C.G. Weishaupt s.n.* (OS); Fairborn, along railroad, Kauffman Ave., 2 Sep 1975, *C. G. Weishaupt s.n.* (OS); Fairborn, along railroad, Central Ave., 15 Aug 1980, *C. G. Weishaupt s.n.* (OS). Hamilton County: Cincinnati, lawn, Eden Park, 24 Jul 1974, *J. H. Carpenter 111* (KNK, OS); Cincinnati, Spring Grove Ave., 24 Aug 1991, *J. W. Thieret 57168* (KE); Wyoming, county fairgrounds, 11 Sep 1996 *A. W. Cusick 33408* (CM, MICH, OS). Miami County: Troy, grassy area along Great Miami River at Troy Community Park, Main Street, 5 Sep 2002, *M. A. Vincent 10867* (MU). Montgomery County: Dayton, along railroad tracks, 20 Aug 1979, *W. R. Carr 2078* (KE, OS). Pickaway County: South Bloomfield, US Rt 23 & Main St., tree lawn, 25 Sep 2003, *A. W. Cusick 36147* (MU, OS). Sandusky County: Madison Twp., North Union Cemetery, 26 Sep 2000, *A. W. Cusick 35666* (MU).

REVIEW

Adams, Robert P. Junipers of the World: The genus *Juniperus*. 2004. Trafford Publishing Company, Vancouver, British Columbia, Canada; www.trafford.com. ISBN 1-4120-4250-X. vi + 275 pp. Softcover, U.S.$39.95, C$50.00.

In order to purchase this book, you must go to the publisher's website, and charge it against a credit card. The book is then published on demand, and your credit card is charged for the book plus shipping and handling. Presumably, the book exists on a CD. One of the features this company offers is the possibility of altering and correcting the book—that could conceivably mean that your copy of the book will differ from mine. So far as I can tell, there are no nomenclatural novelties in the book, but you can well imagine the difficulties that could arise when one cites a [potentially] continuously changing book.

The opening line of the book is an intriguing one: "*Juniperus* is the second most diverse genus of the conifers." The reader waits, so to speak, for the other shoe to fall, but it never does. At a guess, I'd say the author's intention was to add ". . . after *Pinus*."

The keys begin on page 53. That's what most people are going to want to turn to. For convenience, the author has divided the keys up into geographic segments, which is a great help to the reader. Thereafter, the treatment of each of the 67 species is alphabetical. There is a very full synonymy given for each taxon, and an ample description, together with one or more photographs. In Appendix IV, we have "Seed cones and leaves in color." The pictures are likewise arranged alphabetically.

Appendix II is a cross-indexed synonymy of *Juniperus*; that is to say, a nomenclator. This promises to be of great use to herbarium curators especially.

There is a difficulty in the Literature Cited. Professor Adams cites about 75 papers of which he is the first author and sometimes the sole author. But they're not in chronological order. Hence, "Adams 1989" could show up just about anywhere. There's a citation of "Adams et al. 2003" on page 10. I cannot for the life of me be sure what the reference is, though I *think* it is to the second entry on page 216; in fact, there are four different papers that could be "Adams et al. 2003." Then on page 11, there's a reference to "Adams 2003," and so far as I could discover there is no such single-authored paper for 2003. From the context, I infer he meant "Adams et al. 2003," but that still leaves me four possible references.

One doesn't need this book to identify the species of *Juniperus* around the Great Lakes. But if your net is cast a bit wider, then I think the book will prove to be invaluable. It does allow you to see your local populations of various juniper species in a broader context. We are fortunate that the author's worldwide experience with junipers is here in one place, and at a very fair price.

There is no index, so if you want to return to the story about how the Gyrfalcon (*Falco rusticolus*) might be involved in the post-glacial plant colonization of Greenland from Iceland, you might want to write the page reference inside the covers.

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MOSSES AND LIVERWORTS OF THE KALAMAZOO NATURE CENTER A PRELIMINARY SURVEY

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During the summer of 2004, I made seven visits to the Kalamazoo Nature Center's 1100 acre tract at 7000 N. Westnedge Ave., approximately 5 miles north of Kalamazoo, Michigan. The visits lasted about three hours each. Six visits were made to different parts of the tract to collect moss and liverwort specimens. The seventh visit was made to place labels for the seven most common liverworts and mosses along trails in the hope that a guide sheet could be prepared and given to visitors interested in learning about these plants. Mr. Tyler Bassett of the KNC research staff accompanied all my visits to insure that areas collected were properly identified. He also independently collected a number of specimens for inclusion in this report. This study was conducted as part of the KNC Bioinventory project and was supported by a grant from the Hanes Fund.

The six collecting trips, areas visited, and the number of collections made are presented below in Table 1.

Microscopic examination of the 127 collections resulted in 152 moss and liverwort identifications, representing 55 different species. In some collections several species were growing intertwined. The 55 species identified probably represent 90+% of all moss and liverwort species growing on the KNC property. A recent 3-year study in Cass County of a 1400-acre tract resulted in 277 collections, representing 59 different species of mosses and liverworts, including seven species of *Sphagnum*. Only one species of *Sphagnum* was collected on the KNC tract, due to the fact that there are no bogs on the property. To get beyond the 90+% level would require more collecting trips, particularly into areas of the KNC not visited in the present study.

TABLE 1. Bryophyte collecting trips to the Kalamazoo Nature Center

Date	Areas Visited	# of collections made
9 June 2004	C1	13
18 June 2004	E2, Source Pond	17
15 July 2004	S1, F3, O3	27
28 July 2004	F1, C1	23
16 August 2004	G, C3, F2	27
23 August 2004	U4, M, S3	13
Collected by Tyler Bassett		7
		127 total collections

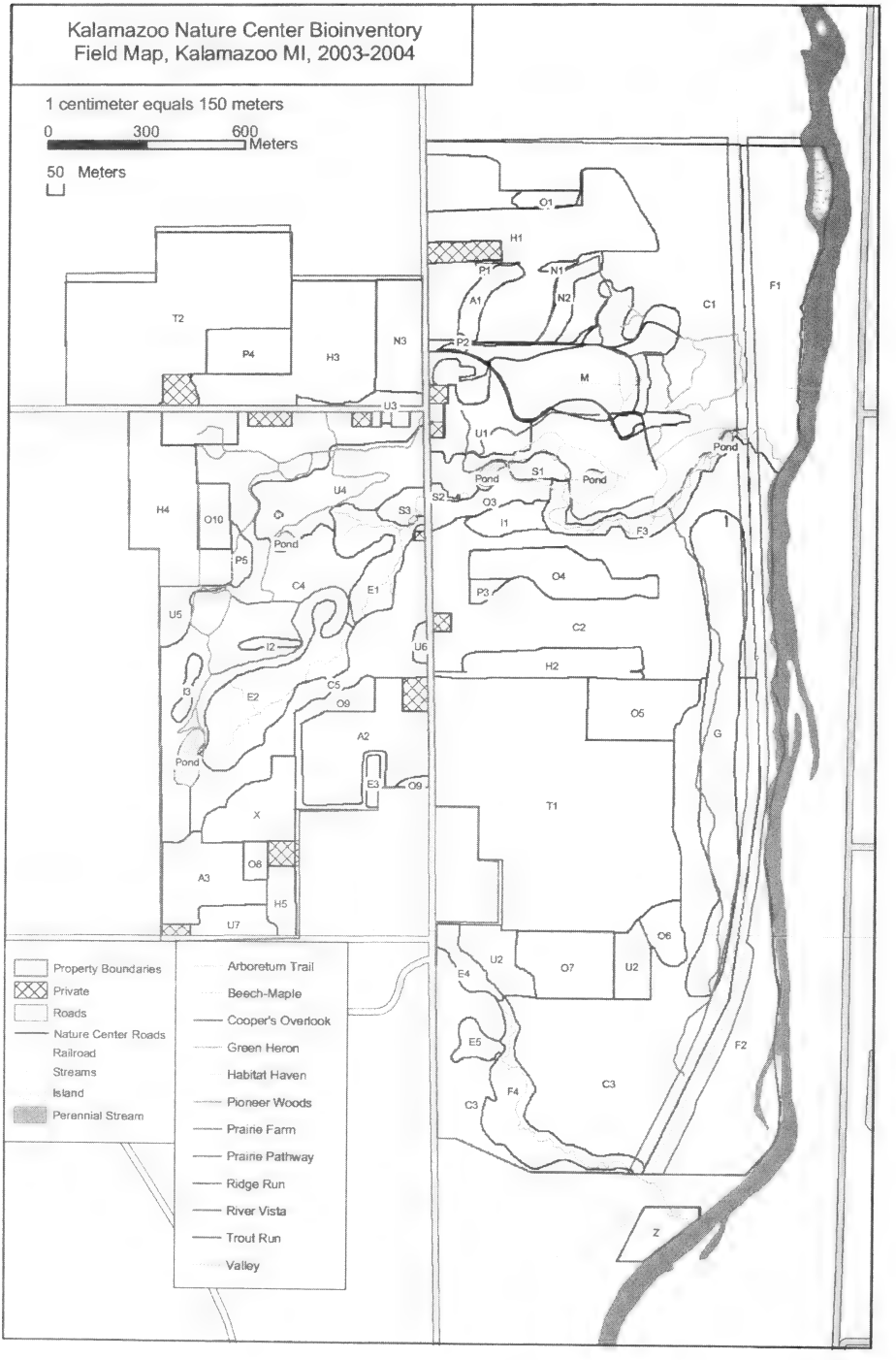

FIGURE 1. Kalamazoo Nature Center Biodiversity Field Map

TABLE 2. Kalamazoo Nature Center Biodiversity Study—Field Map Compartment Codes, representing collecting sites for bryophytes in this study.

C1	Central Hardwood; forest north of Trout Run, west of railroad, east of Arboretum.
C3	Central Hardwood; forest south of corn field, west of railroad.
E2	Emergent Marsh
F1	Floodplain; southern floodplain forest and various open wetland types along the Kalamazoo River; southern border is Trout Run.
F2	Floodplain; adjacent to F1; northern border is Trout Run.
F3	Floodplain; starts at the SE end of S1 and follows Trout Run lowlands to railroad
G	Gravel Pit; oppposte forested ridges mark the borders; or railroad, or treeline.
M	Manicured; includes Arboretum, barnyard, and all parking lots.
O3	Oldfield; esker where bluebird boxes are installed.
S1	Sedge Meadow; area generally regarded as a fen; Habitat Haven trail circles around it.
S3	Sedge Meadow; generally regarded as a fen; east border is Westnedge Avenue, the south border is Trout Run, and north border is an upland thicket, and the west border is indeterminate.
Source Pond	This is the largest pond on the property, near the western boundary.
U4	Upland Shrubland; a mosaic of open woods, dense shrubland, open shrubland, and non-native grassland; follows trails (Green Heron and Pioneer Woods).

Information on the 55 species of mosses and liverworts is presented in two different lists. The first is an annotated list of the species arranged in alphabetical order along with descriptions of the microenvironments in which each is found, the number of times each was collected, and estimates of its frequency on the property. Each listing begins with the scientific or technical name of the moss or liverwort. This consists of the genus and species to which it belongs and the name(s) of the person(s) who created the currently accepted binomial. This is followed by the common name of the plant for those mosses and liverworts having common names. Many of the common names follow those of Glime (1993). The number in parentheses indicates the number of times it was identified in the collections. This is followed by an estimate of its frequency on the KNC property and the type of microenvironment in which it occurs. Each listing ends with the areas of the KNC in which the species was found. The areas listed are those on the compartment map of the KNC property provided by the KNC research staff (Fig. 1 & Table 2). The second is a taxonomic list which presents the 55 species arranged by class, order, and family. All nomenclature and the sequence of families and orders is based on Crum (1983) and Crum (1991); the author citations are those adopted by W^3MOST at www.mobot.org. A set of collections representing all 55 species is being prepared for the KNC. Except for

the most common species, which have been discarded, all other collections will be housed in the Hanes Herbarium at Western Michigan University.

AN ANNOTATED LIST OF THE MOSSES AND LIVERWORTS OF THE KNC

Amblystegium serpens (Hedw.) Schimp. (10); common; in damp or wet places, usually on rotting logs, occasionally on soil; C1, C3, F1, F2, F3, G.

Anomodon attenuatus (Hedw.) Huebener; "Tree Apron Moss"; (4); frequent; on tree bases; F1, F2, F3, Source Pond.

Anomodon rostratus (Hedw.) Schimp.; (1); infrequent; on tree base; C1

Atrichum angustatum (Brid.) Bruch & Schimp.; "Star Moss"; (3); common; soil along trailsides and on forest floor; C1, S1.

Brachythecium oxycladon (Brid.) A. Jaeger; "Cedar Moss"; (1); infrequent; bank of Source Pond.

Brachythecium rutabulum (Hedw.) Schimp. (2); "Cedar Moss"; infrequent; on soil and bases of trees; C1, M.

Brachythecium salebrosum (Hoffm. ex F. Weber & D. Mohr) Schimp.; "Cedar Moss"; (11); common; on soil, rotting logs, tree bases and rocks; in woods, along river bank and in seep spots; C1, F2, O3, U4.

Bryhnia graminicolor (Brid.) Grout; (1); infrequent; on rock in streambed; F3.

Bryum argenteum Hedw.; "Silvery Moss" ; (1); infrequent; on soil in roadway; G.

Bryum creberrimum Taylor; (2); infrequent; among rocks in RR bed; C1.

Callicladium haldanianum (Grev.) H. A. Crum; "Shiny Moss"; (2); frequent; rotting logs and tree trunks in woods and at edge of fen; C1, S1.

Calypogeja muelleriana (Schiffn.) Mull. ; "Sack Liverwort"; (2); infrequent; rotting logs and tree bases in woods and at Source Pond ; C4.

Campylium chrysophyllum (Brid.) Lange ; (l); infrequent; soil on Ridge Run Trail; C1.

Campylium radicale (P.Beauv.) Grout; (2); infrequent; rotting logs at end of esker and with Typha in fen; O3, S3.

Campylium stellatum (Hedw.) C. E. O. Jensen ; (1); infrequent; calcareous seep; E 2.

Ceratodon purpureus (Hedw.) Brid. ; "Purple Cord Moss"; (1); infrequent; on sandy soil in roadway; G.

Chiloscyphus pallescens (Ehrh. ex Hoffm.) Dumort.; "Squareleaved Liverwort"; (1); infrequent; soil at tree base; C1.

Chiloscyphus polyanthus (L.) Corda ; "Squareleaved Liverwort"; (1); infrequent; rotting log, bank of Trout Run; F3.

Climacium dendroides (Hedw.) F. Weber & D. Mohr; "Christmas Tree Moss"; (3); frequent; in lawn at F Ave., along streambank , near Valley Trail; C1, F3.

Conocephalum conicum (L.) Underw.; "Scented Liverwort";(2); infrequent; streamside banks; C1, F3.

Cratoneuron filicinum (Hedw.) Spruce; (3); infrequent; calcareous fens and seeps; E2, F3, S1.

Drepanocladus aduncus (Hedw.) Warnst.; "Sickle Moss"; (1); infrequent; calcareous fen; S1.

Entodon cladorrhizans (Hedw.) Müll. Hal. ; (1); infrequent; rotting log; C3.

Entodon seductrix (Hedw.) Müll. Hal.; (4); frequent; rotting logs and tree bases; C3, F1, F2.

Eurhynchium hians (Hedw.) Sande Lac; (2); infrequent; trailside bank at edge of fen and soil near river. F2, S1.

Eurhynchium pulchellum (Hedw.) Jenn.; (2); infrequent; soil in woods; U4.

Fissidens adianthoides Hedw. ; (1); infrequent; on rock at side of esker; O3.

Fissidens taxifolius Hedw.; "Flat-Ironed Moss"; (10); common; on soil or rocks in damp or wet shady places; C1, F2, M, O3, S1, U4.

Frullania eboracensis Gottsche; (1); infrequent; tree trunk at edge of fen; S1.

Funaria hygrometrica Hedw.; "Twistedcord moss";(1); infrequent; among rocks in RR bed; C1.

Homomallium adnatum (Hedw.) Broth.; (1); infrequent; rotting log; O3.
Hygroamblystegium tenax (Hedw.) Jenn.; "Brookside feather moss"; (3); frequent; tree base near river and on rocks at seep spot; C1, F1.
Hypnum fertile Sendtn.; (1); infrequent; with *Typha* in fen; S3.
Hypnum pallescens (Hedw.) P. Beauv.; (1); infrequent; tree base near Research House.

Leptodictyum humile (P. Beauv.) Ochyra; (3); infrequent; rotting logs and soil banks; F2, S1, Source Pond.
Leptodictyum riparium (Hedw.) Warnst.; "Willow moss"; (8); common; soil, tree bases, rotting logs, rocks in streambed; C1, F1, F2, F3, M, O3.
Leucobryum albidum (Brid. ex P. Beauv.) Lindb. ; "Small Pin Cushion Moss"; (1); infrequent; hummock in Source Marsh; E1.
Leucobryum glaucum (Hedw.) Ångström; "Pincushion moss"; (1); infrequent but locally abundant on trailside bank at edge of fen; S1.
Lophocolea heterophylla (Schrad.) Dum. "Crested Liverwort"; (11); common; on rotting logs, occasionally on soil or rock in damp shaded places; C1, C4, E2, F1, F2.

Mnium affine Blandow ex Funck; (1); infrequent; on soil along trail; C1.
Mnium cuspidatum Hedw.; "Woodsy Mnium"; (12); common; rotting logs, soil, rock; C1, F2, G, M, O3, U4, bank of Source Pond.
Mnium punctatum Hedw.; (l); infrequent; on soil in the lobe portion of Shrub Swamp; E1.

Nowellia curvifolia (Dicks.) Mitt. ;(1); infrequent; rotting logs near river; F1.

Pallavacinia lyellii (Hook.) Caruth.; (1); infrequent; calcareous seep; E2.
Plagiochila porelloides (Torr. ex Nees) Lindenb. ; (1); infrequent; on ground above Trout Run; C1.
Platygyrium repens (Brid.) Schimp.; (10); common; tree bases, tree trunks, rotting logs; C1, F1, F2, S1, edge of Source Pond.
Pohlia nutans (Hedw.) Lindb.; "Nodding Pohlia"; (1); infrequent; with *Typha* in fen; S3.
Polytrichum commune Hedw.; "Common Haircap Moss"; (1); infrequent; soil at edge of fen; E2.
Polytrichum piliferum Hedw.; "Awned Haircap Moss"; (1); infrequent; soil at edge of fen; E2.
Porella platyphylla (L.) Pfeiff.; "False Selaginella"; (1); infrequent; tree base; C1.

Rhynchostegium serrulatum (Hedw.) A. Jaeger; (2); infrequent; on soil, trailside and seep spot; C1, O3.

Sphagnum russowii Warnst.; (1); infrequent; on hummock in the lobe portion of Source Marsh; E1.

Thuidium delicatulum (Hedw.) Schimp.; "Fern Moss"; (4); common; on soil, rocks, and rotting logs; C1, G, O3.
Thuidium recognitum (Hedw.) Lindb.; (3); infrequent; soil near tree base, edge of fen; E2, Source Pond.
Trichocolea tomentella (Ehrh.) Dumort. ; (1); infrequent; on hummock in the lobe portion of Source Marsh; E1.

TAXONOMIC LIST OF THE MOSSES AND LIVERWORTS OF THE KALAMAZOO NATURE CENTER

BRYOPHYTA

HEPATICOPSIDA (LIVERWORTS)
MARCHANTIALES (multistratose thalloid liverworts)
Conocephalaceae
Conocephalum conicum (L.) Lindb.
METZGERIALES (unistratose thalloid liverworts)

Pallavaciniaceae
Pallavacinia lyellii (Hook.) Caruth.
JUNGERMANNIALES (leafy liverworts)
Trichocoleaceae
Trichocolea tomentella (Ehrh.) Dumort.
Calypogejaceae
Calypogeja muelleriana (Schiffn.) K. Mull.
Geocalycaceae
Lophocolea heterophylla (Schrad.) Dumort.
Chiloscyphus pallescens (Ehrh. ex Hoffm.) Dumort.
Chiloscyphus polyanthus (L.) Corda
Cephaloziaceae
Nowellia curvifolia (Dicks.) Mitt.
Plagiochilaceae
Plagiochila porelloides (Torr. ex Nees) Lindenb.
Porellaceae
Porella platyphylla (L.) Pfeiff.
Jubulaceae
Frullania eboracensis Gottsche
SPHAGNOPSIDA (the sphagnum mosses)
Sphagnaceae
Sphagnum russowii Warnst.
BRYOPSIDA (the true mosses)
Fissidentaceae
Fissidens adianthoides Hedw.
Fissidens taxifolius Hedw.
Ditrichaceae
Ceratodon purpureus (Hedw.) Brid.
Leucobryaceae
Leucobryum glaucum (Hedw.) Ångström
Leucobryum albidum (Brid. ex P. Beauv.) Lindb.
Funariaceae
Funaria hygrometrica Hedw.
Bryaceae
Pohlia nutans (Hedw.) Lindb.
Bryum argenteum Hedw.
Bryum creberrimum Taylor
Mniaceae
Mnium cuspidatum Hedw.
Mnium affine Blandow ex Funck
Mnium punctatum Hedw.
Leskeaceae
Anomodon rostratus (Hedw.) Schimp.
Anomodon attenuatus (Hedw.) Huebener
Thuidium recognitum (Hedw.) Lindb.
Thuidium delicatulum (Hedw.) Schimp.
Amblystegiaceae
Cratoneuron filicinum (Hedw.) Spruce
Campylium chrysophyllum (Brid.) Lange
Campylium radicale (P. Beauv.) Grout
Campylium stellatum (Hedw.) C. E. O. Jensen
Leptodictyum riparium (Hedw.) Warnst.
Leptodictyum humile (P. Beauv.) Ochyra
Hygroamblystegium tenax (Hedw.) Jenn.
Amblystegium serpens (Hedw.) Schimp.
Drepanocladus aduncus (Hedw.) Warnst.
Brachytheciaceae

Brachythecium oxycladon (Brid.) A. Jaeger
Brachythecium salebrosum (Hoffm. ex F. Weber & D. Mohr) Schimp.
Brachythecium rutabulum (Hedw.) Schimp.
Bryhnia graminicolor (Brid.) Grout
Eurhynchium pulchellum (Hedw.) Jenn.
Eurhynchium hians (Hedw.) Sande Lac.
Rhynchostegium serrulatum (Hedw.) A. Jaeger
Entodonaceae
Entodon cladorrhizans (Hedw.) Müll. Hal.
Entodon seductrix (Hedw.) Müll. Hal.
Hypnaceae
Platygyrium repens (Brid.) Schimp.
Homomallium adnatum (Hedw.) Broth.
Hypnum pallescens (Hedw.) P. Beauv.
Hypnum fertile Sendtn.
Callicladium haldanianum (Grev.) H. A. Crum
Climaceae
Climacium dendroides (Hedw.) F. Weber & D. Mohr
Polytrichaceae
Atrichum angustatum (Brid.) Bruch. & Schimp.
Polytrichum piliferum Hedw.
Polytrichum commune Hedw.

SUMMARY AND INTERPRETATION

Six trips to the Kalamazoo Nature Center during the summer of 2004 produced 127 moss and liverwort collections representing 55 species. These are entirely typical of the bryoflora of southwest Michigan. Comparison with studies of similar tracts suggests that the 55 species represent 90+% of all moss and liverwort species on the KNC property. The number of species present is held down by the lack of bogs, rock outcroppings, and water-falls on the KNC property. These are habitats in which many moss and liverwort species thrive.

The richest environments on the KNC property for mosses and liverworts are the mature forests along the Cooper Glen Trail, the bed and borders of Trout Run, the edges of the Source Pond and the flood plain of the Kalamazoo River. The single richest microenvironment is rotting logs, particularly when they have become decorticated.

No rare or endangered bryophyte species were encountered during this study. In fact, most of the species found at the KNC are quite widespread. Some of them are circumboreal in distribution and represent remnants of the great Tertiary age forests that once clothed the northern hemisphere of the planet. There is an amazing similarity in the bryoflora of southern Michigan from place to place. Thus, one can be quite confident that one will find *Fissidens, Thuidium, Mnium, Lopohocolea* and a number of other genera each time you step into a Southwest Michigan woodlot. To be sure, there are differences from place to place as well. This is the result of the fact that some of the species are quite widespread but don't occur everywhere. Plants like *Porella*, *Climacium*, *Nowellia*, and *Pallavacinia* are always a surprise wherever they are found.

The bryoflora of the KNC is rich enough to contain many delights to point out to visitors and complex enough to merit further study.

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THE HISTORICAL DEVELOPMENT OF THE TENSION ZONE CONCEPT IN THE GREAT LAKES REGION OF NORTH AMERICA

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ABSTRACT

John T. Curtis' detailed work with Wisconsin plant communities synthesized the range limits of 182 plant species into a northwest to southeast diagonal zone across the state. This paper combines Curtis' synthesis with similar work from other Great Lakes areas into a regional view of the tension zone concept. The search for spatial pattern helped form early ecological thinking in the U.S.

INTRODUCTION

The concept of a tension zone or transitional area between two types of vegetation was first discussed in the late 1800s and early 1900s by botanists and ecologists who were studying the boundaries of plant communities. After the Civil War, there was considerable work being carried out in the United States in determining the geographic extent of biological resources as well as climatic zones. Various federal and state agencies conducted biological surveys in the sparsely-populated area west of the Mississippi River as railroads and European-American settlement expanded westward. Some of the first biologists who contributed to the newly developing discipline of ecology were participants in these surveys (McIntosh 1985, pp. 48–49). Botanists and plant ecologists began to study the tension zone concept as a tool for understanding the dynamics and spatial structure of plant communities. The idea of tension, or transition, zones is largely limited to use in the Great Lakes region of North America (Minnesota, Wisconsin, Michigan, Ohio, and southern Ontario), particularly in the boundary between the eastern deciduous forest (with the prairie that replaces it as one moves westward) and the mixed hardwoods forest of the region. The tension zone concept was especially applied to Wisconsin with John T. Curtis' detailed work in mapping the distribution of the plant communities.

DEFINITIONS

Tension is a dynamic quality, involving a pull of forces and a resultant stress or strain. Merriam-Webster (1993) defines tension as: "the act or action of stretching or the condition or degree of being stretched to stiffness" and as: "either of

two balancing forces causing or tending to cause extension." As used by plant ecologists, a tension zone is a transitional area where there is an active relationship between either different plant associations or between the requirements of a plant association and the total environment, including such factors as climate, topography, and soils. There is reasonable agreement on the definition among ecologists. A tension zone is described as a "boundary between floristic provinces (USA)" (Resinger and Gomez Gutierrez 1992, p. 295); a band between two floristic provinces, "which contains some members of each" (Curtis 1959, p. 15); a boundary "between floristic provinces" that coincides "with the distributional limits of many species" (Krebs 1994, p. 446); and "an area where there is much change in vegetation in a comparatively narrow zone" (McCann 1979, p.1). D. J. de Laubenfels (1975) made the distinction that tension zones occur where there are less perceptible boundaries between roughly similar plant communities, such as between savanna and brush, rather than a continuous gradient between extremes, such as between grassland and woodland. Tension zones may occur at different scales—between different plant species and between plant societies (Griggs 1914). However, in the most common use of the term in plant ecology, a tension zone occurs at the level of plant communities on a regional scale.

FOUNDATIONAL WORK

Although the actual term "tension zone" was not used until the early 1900s, there was considerable discussion of similar ideas in the late 1800s which provided a basis for its subsequent development. Groundwork for the concept was established in Wisconsin with the works of J.G. Knapp (1871a, 1871b) and L.S. Cheney (1894). Both of these writers proposed schemes of vegetation classification for the state which were closely related to agriculture and timber production. At least part of the purpose of these classifications seemed to be educating state residents about which regions were best suited to various types of agriculture and forestry.

Knapp published two papers in 1871 through the State Horticultural Society, along with a map of mean temperatures in Wisconsin and suitability areas for growing dent corn, Concord grape, and pear and cherry trees. In "The Native Vegetation of Wisconsin" (1871b), he divided the native vegetation into four divisions, or "vegetable belts": the Canadian, the Ontario, the Michigan, and the Wisconsin. For each belt, Knapp listed the predominant tree and shrub species, and some herbaceous plants. He commented generally on the climate of each belt, including snowfall, rainfall, and temperatures; and also described general soil characteristics. The economic nature of the era is evident in his comments on the potential of each belt for various forms of agriculture and timber production. He correlated the vegetation belts with isothermal and rain lines of the state, saying that they were closely related.

In his paper, "The Isothermal Lines of Wisconsin" (1871a), Knapp examined the pattern of mean temperature lines across the state. His map (in the same volume as his two papers) shows these mean temperature lines for January and July

which run in a northwest to southeast diagonal pattern. On the same map, the "Northern Limit of Dent Corn and Concord Grape" is shown as a line in basically the same diagonal fashion. He also showed a line for the "Northern Limit of the Pear and Cherry" which runs from Prairie du Chien through Baraboo and up the eastern side of Oconto County to Washington Island in Door County. Knapp was adamant on the need for horticulturalists to recognize climatic conditions as paramount in their considerations of what plants to grow and where to grow them. He advocated the use of climate information in both adapting to the natural limits and in the planting of masses of trees and shrubs to ameliorate the effects of climate.

L.S. Cheney published a paper (1894) titled "Is Forest Culture in Wisconsin Desirable? Is It Practicable?" In this paper, Cheney delineated two major vegetative provinces in Wisconsin: prairie in the southern part of the state with "scattering groves of oak" and the pine region in the northern part of the state. His argument was that the timber cutting practices in Wisconsin needed to be changed from that of exploitation and destruction of the forest to a more long-term forest culture that would restore forest cover through protection of what remained, replanting, and establishment of new forests. He gave examples of profitable forest management both in Europe and in other parts of the United States. On lands which were unsuitable for agriculture, such as "1,365,000 acres of tamarack and cedar swamp land"—basically the northern part of the state (almost 4,000,000 acres by his estimate), he advocated "systematic forest cultivation."

Clinton Hart Merriam was a zoologist who became the first head, in 1888, of the Division of Economic Ornithology and Mammalogy of the U.S. Department of Agriculture. Merriam's "Laws of temperature control of geographic distribution" were among the most often cited "laws" of nineteenth century ecology (McIntosh 1985, p.64) and were based on the idea that "animals and plants are restricted in northward distribution by the total quantity of heat during the season of growth and reproduction" (Merriam 1894). In 1898, he published "Life zones and crop zones," a work that was influential with some botanists (Griggs 1914). This bulletin was based on the data he collected on expeditions across the country, especially through Arizona and the West in 1889. He collected information on the distribution of plants and animals at different elevations and the relation between temperature and distribution. Each "life zone" he described had characteristic species of plants and animals. He believed that temperature was the main cause, particularly during the growing season, of the distribution of vegetation types (Barbour et al. 1980).

Perhaps the major contribution of these early ecological studies by Merriam, Knapp, and Cheney is that they gathered large amounts of data and attempted to see the larger picture—characterizing ecological zones at broader scales than had been done previously in the United States. Although Merriam's work was influential at that time and still is useful in the mountainous regions of the west, it was later discounted for much of the country and found to be based on inadequate theoretical foundations (Egerton 1976). Pre-1900 plant and animal ecology characterized communities as relatively static and falling within discrete classifications. In the late 1800s, this view began to give way to ecological perspec-

tives which recognized the dynamic nature of the environment, including the tension zone concept.

THE TENSION ZONE CONCEPT

Conway MacMillan was one of Charles Bessey's students at the University of Nebraska, where he earned his bachelor's and master's degrees in 1885 and 1886 respectively. MacMillan joined the botany faculty at the University of Minnesota in 1897 and was state botanist of Minnesota (Egerton 1976). He was influenced by the phytogeographical tradition of Alexander von Humboldt, Oscar Drude, and other German geographical botanists and their work with developing zonal classifications of vegetation. He published several ecological surveys of Minnesota vegetation. His book, *The Metaspermae of the Minnesota Valley* (1892), was praised by Bessey as a pioneering investigation of an area with natural boundaries, rather than political or scientific ones. However, some of MacMillan's work was criticized by the botanists Russell Pound and Frederic Clements (1897, cited in McIntosh 1985) as being too focused on the physical environment.

In *The Metaspermae of the Minnesota Valley* (1892), MacMillan provided an exhaustive listing of 1174 plant species and where they had been found to occur in North America and in the Minnesota River valley. In a section titled "Distribution of the forest and prairie," MacMillan wrote of the intermediate area between the forest and prairie. In another section called "The dynamic inter-relations of plants," he wrote of plants competing dynamically, saying:

> We no longer permit ourselves to look at a grove standing in the midst of the prairie as stable or even as quiescent, but we picture to ourselves the complex condition of strain which exists in varying degree and under different degrees of organization, between the different plants, species and groups of species. (p. 584)

MacMillan referred to the expansive movement of northern groups of plants as "south-bound" and of those with a southern range as "north-bound."

In the same book (1892), MacMillan wrote in a general way of "Pressures and Tensions" in describing the physical and biological forces shaping vegetation of the Minnesota River valley. He compared these factors to forces in physics with the "the weaker plants of a formation crowded to its periphery where they meet and struggle with the weaker plants of an adjacent formation." This transitional area he defined as "a zone of plants not perfectly established in either forest or prairie." The tensions he wrote of in this section were mostly continental in scope, such as climate and topography, but he did not refer much to tensions between vegetation types. He does refer to a general tension between plants in his summary but this idea was not developed fully in this book.

MacMillan coined the term "tension-line" (1893) in describing a transitional area between the two plant formations: the forest and the prairie in the eastern portion of the United States. This region he defined as "a very narrow strip of plants imperfectly developed in either forest or prairie" and believed it to be

found anywhere two different formations met. Tension-line characteristics which MacMillan noted were: typical tension-line groups of species distinct from the typical prairie groups and typical forest groups, greater richness of species and more numerous individuals than in the neighboring formations, movement of the tension-line as formations advance and retreat, effects of the tension-line have influence at some distance into the adjacent formations as one formation encroaches upon another, and the movement of plants from the formations bordering the tension-line as they "work out" into the tension-line area. The term "tension-line" is a little misleading since MacMillan repeatedly refers to this concept as not necessarily a thin line but as a region, a "thicker or thinner band of tension-line species" or "the tension-area."

In his 1899 book on Minnesota vegetation, MacMillan stated (p. 10) that plant populations of two regions are in "a state of *tension* [his emphasis], and the line between them is necessarily slowly shifting and irregular." MacMillan wrote of tensions at different temporal scales. The tension between forest and prairie, he termed a continental tension. Minor tensions at a finer scale, such as between knolls and ravines, were described as similar but differing in their shorter history.

The term *tension zone* was first used by an early ecologist, Burton Edward Livingston (1903), in describing a space where different plant communities reached their boundaries. He referred to the "zone of tension" between the upland plant societies he studied in Kent County, Michigan. Livingston described an area along a "wavy east and west line" through the county that marked the limits of five different plant societies. His conclusion was that soil was the ultimate cause of the vegetation pattern, along with climatic, historical, and physiographic influences.

In 1914, Robert F. Griggs utilized the tension zone concept in his paper about vegetation in the Sugar Grove region of Fairfield County, Ohio. In this area, there is a high proportion of species at the edges of their ranges. Griggs questioned why plant boundaries occur in certain areas and what factors decide the limits of their ranges. From his data on species abundance, he concluded that competition with different species was more influential than climatic factors in determining range limits, although he said that climatic conditions were also an important factor. His study at least partially disproved the idea (attributed to Blytt) that species at the limits of their ranges are restricted to areas with the most favorable conditions.

Griggs pointed out that the tension zones between plant species apparently resemble the tension zones between plant societies. In the former, some species advance at the same time as other species are being forced back. He emphasized the importance of studying tension zones to ascertain the geographical movements of plant societies, stating that "the exceedingly slow movements of vegetation may be readily detected by observations of the tension zones between the ranges" (p. 49). Griggs' observations show the dynamic nature of the Sugar Grove vegetation, with boreal species pushing other species west and south. In the conclusion to his paper, Griggs stated that the tension zone concept is useful for learning more about this shifting interplay of species at the edges of their zones.

John T. Curtis and Robert P. McIntosh (1951) examined the upland hardwood forests in the prairie-forest border area of Wisconsin and their relationships with each other and with the environmental factors of soil acidity, nutrients, and moisture. They pointed out the 1894 work of Cheney in classifying Wisconsin's vegetation into two floristic provinces, the prairie and hardwood forest region in the southwest part of the state and the hardwood and coniferous forest region in the northeastern part. Applying Griggs' tension zone idea, they remarked that the diagonal boundary zone between these two provinces contains members of each province. Using a method developed by Frederick Clements in his text (1905), Curtis and McIntosh stated that the location of the tension zone (which Clements termed a "limiting line or ecotone of a . . . province") could be delineated by combining the territorial limits of principal species and verifying these against the range limits of typical species of the contiguous vegetation. The southwest zone they called the prairie-forest province and the northeast zone the northern hardwoods province.

Curtis and McIntosh sampled the vascular species (herbs, shrubs, and trees) from a random sample of 95 forest stands in 29 counties. They also sampled the soils in most of the stands. In determining the environmental factors of each stand, Curtis and McIntosh calculated importance values, constancy, and average frequency for species. These attributes were the basis for assigning a relative value to each species, which they called a "climax adaptation number." Multiplying the adaptation number by the importance value of a species in a particular stand produced a suite of weighted numbers added together giving a single number for that stand, which they termed the "vegetation continuum index." By this method, they found support for their hypothesis that the upland hardwood forests of southwestern Wisconsin "represent a continuum in which no clearly defined subdivisions are discernable but in which a definite gradient is exhibited." This idea of continuum built upon Henry Gleason's "individualistic concept of the plant association" and was in distinct contrast with the view prominent in ecology up until then: the discrete view of associations championed by other ecologists, primarily Frederick Clements.

In Chapter One of his text, Vegetation of Wisconsin (1959), Curtis traced the concept of the tension zone through the earlier work of J. S. Knapp, L. S. Cheney, B. E. Livingston, and R. F. Griggs. Curtis made distribution maps for Wisconsin plant species based upon the notes and species maps of Cheney for tree species and the work done by Norman Fassett and his students from 1929 to 1953 for non-tree species (Fassett 1929, 1930, 1931, 1939, 1943, 1944, 1945, 1951, Fassett & Calhoun 1952). Curtis gave a cautionary note about the range maps derived from Fassett's work: that since the distribution maps were derived only from herbarium specimens, the choice of species may have been somewhat biased. Taxonomists often collect more unusual specimens at the expense of more commonly occurring ones. Nevertheless, the distribution maps are a valuable source of information and give range limits for a large number of Wisconsin species.

Curtis' tension zone across Wisconsin is a synthesis of the range limits for 182 species of plants. Curtis compiled composite maps based on groups of species, such as sixteen species of *Gramineae* (grass family), eleven species of

Leguminosae (legume family), and thirty species of trees. Taken as a whole, most of the range boundaries fall within a northwest to southeast diagonal zone across the state. The width of the zone varies from 10 to 15 miles to 20 to 30 miles. This tension zone, as Curtis noted, is quite similar to the line Knapp defined in 1871 for the limits of certain horticultural crops. This tension zone for plants coincides with the range limits of a number of animal species, including many birds and fishes (Greene 1935).

The tension zone can also be traced through Minnesota, Michigan, and Ohio, according to Curtis (1959). He stated that the tension zone is distinct in northwest Minnesota but becomes less clear in the southeast. Presumably, Curtis meant that the tension zone is the eastern deciduous forest vegetation type that separates the northern coniferous forest and tallgrass prairie vegetation types (Wendt and Coffin 1988). These three major vegetation types in Minnesota follow a northwest to southeast diagonal pattern and the eastern deciduous forest zone appears to match the western edge of the tension zone Curtis found in Wisconsin. No detail is given on the tension zone in Michigan. However, Curtis cited Griggs' (1914) work in eastern Ohio as evidence of a wide and diffuse tension zone there.

John Adams and others published work in the early part of the 20th century about the distribution of some genera which are of restricted range in Canada's Carolinian Zone (Soper 1962). Soper briefly notes in his paper (1962) that the work of these botanists was instrumental in the development of the tension zone concept in southern Ontario.

The work of Margaret Thompson McCann (1979) for her master's thesis provides information on the tension zone in Michigan that broadens Livingston's work to a statewide perspective. McCann located the tension zone in Michigan's Lower Peninsula and examined possible ecological causes for it. The vegetation of the Lower Peninsula has been found to be arranged into two different types in a north-south pattern. Potzger has determined a tension zone about 60 miles wide across the center of the Lower Peninsula (1946). McCann analyzed the distribution of 649 vascular plant species from herbarium and literature records for their range limits and calculated a zone index value for each county. She found evidence of a floristic tension zone (p. 12), "a concentration of range lines of many species." She noted that a floristic tension zone is different from a vegetation tension zone (p. 12), reflecting "a change in the abundance of the dominant species (such as trees)."

Using her method of mapping northern and southern range limits and calculating zone indexes, McCann (1979) found that many northern range limits of southern plants (species which are found mainly in the southern portion of the Lower Peninsula) were concentrated in a tension zone in the center of the Lower Peninsula in an east-west orientation. Southern range limits of northern plants (species which are found mainly in the northern portion of the Lower Peninsula) did not show a clear pattern.

McCann examined possible reasons for this tension zone, including "soils, topographical barriers, precipitation (amount, season, and kind), evaporation, temperature extremes, frost-free season length, and amount of cold and heat" (1979, p. 69). She compared the plant ranges for each of these possible factors

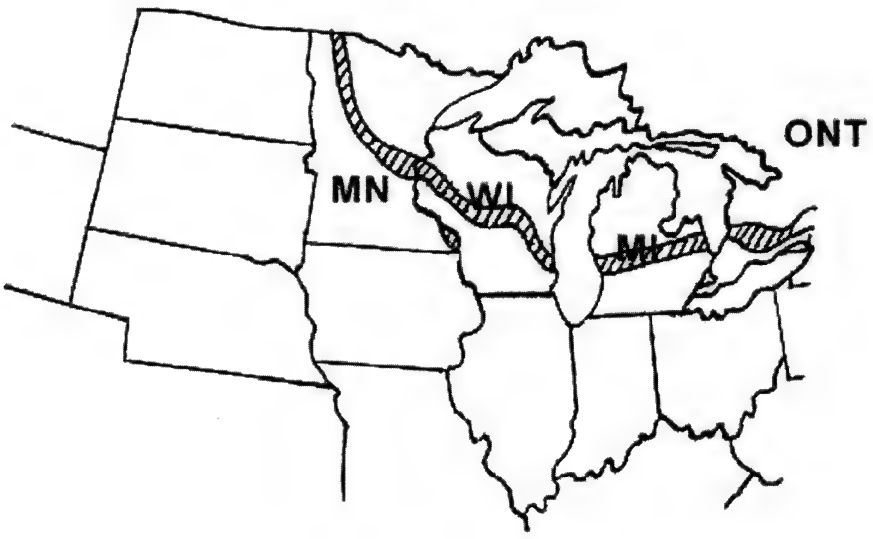

FIGURE 1. Tension zone in Great Lakes region, adapted from Curtis 1959, Wendt & Coffin 1988, McCann 1979, Livingston 1903, Potzger 2946, & Thaler & Plowright 1973.

and concluded that, for most of the plants, insufficient heat (as indicated by growing degree day data) determines the range limits of southern species. In other words, it is too cold for these plants to live north of the tension zone. She found additional support for this conclusion by comparing growing degree day isolines for Wisconsin and southern Ontario with the tension zones found there by Curtis (1959) and Thaler and Plowright (1973) respectively. In both cases, she found the tension zones followed the pattern of the growing degree data, although in southern Ontario, the pattern shows a "weakly developed tension zone" (Thaler and Plowright 1973). Figure 1 shows how the tension zone information of Curtis (1959), Wendt and Coffin (1988), McCann (1979), Livingston (1903), Potzger (1946), and Thaler and Plowright (1973) combined into a regional view encompassing Minnesota, Wisconsin, Michigan, and part of Ontario.

Soper (1962) published a thorough survey and analysis of Carolinian flora, in which he examined some of the genera which have restricted range in southern Ontario. He termed the area a transition zone "between the Deciduous Forest and the Mixed Forest" (p. 54). He recognized the permeability of species distribution in this transition zone and wrote that it is not as though all southern species end their ranges at "a magic line" (p. 54) on a map. Instead, some southern species disappear gradually as one travels from south to north and others extend only into the southern fringes of the transition zone. Some northern species are distributed similarly, only in a north to south direction.

CONCLUSION: THE RELATION BETWEEN THE TENSION ZONE CONCEPT AND THE ECOTONE CONCEPT

From a regional term used to describe a transitional area between floristic provinces, ecologists have broadened the tension zone concept into the idea of ecotones. Ecotones operate at a variety of spatial scales, from the microecotone level where a moss cushion meets the soil to the macroecotone level of different ecosystems (such as desert and tropical forest) connected by mesoecotones (such as a grassland-spruce forest ecotone) (Rusek 1992) .

The tension zone concept and the concept of the ecotone differ in their levels of complexity. The tension zone concept describes a large-scale phenomenon across 10-60 miles, inclusive of a variety of smaller scale vegetation differences within the zone, while the term ecotone is used to mean abrupt change happening between two communities in a particular place either at small scales or as a larger-scale boundary (Barbour et al. 1980). An ecotone is generally defined as a "transition zone between two plant communities" (Krebs 1994); and a "transition line or strip of vegetation between two different communities which has characteristics of both kinds of neighboring vegetation as well as characteristics of its own (e.g., forest-meadow ecotone)" (Resinger and Gomez Gutierrez 1992, pp. 97-98). Barbour (Barbour et al. 1980) described an ecotone as "an intermediate habitat" in which the vegetation can change abruptly. Ecotone approaches synonymy with tension zone, but without the sophistication of the latter. So a tension zone or transition zone is a concept incorporating a more complex understanding of competing forces than the more simplistic "ecotone" or sharp change. Both ecotones and tension zones can vary in width and may consist of changes in vegetation structure, such as grasses to trees, as well as changes in species composition. Although the two terms are associated, ecotone is a more broadly applied term than is tension zone. Ecotones have a variety of causes while a tension zone is more narrowly used to apply only to the range limits of plant species. Causes of ecotones include "disturbance (e.g., fire, human activities)" and "natural edaphic boundaries (e.g., soils, hydrology, climate)" (Johnston et al. 1992). Scales of ecotones range from the level of ecoregions or biomes to community-level and finer (Johnston et al 1992).

There is an emerging consensus among ecologists that ecotones are critical for their ecological roles. Ecotones are an inherent part of most landscapes. Research documents increasing habitat fragmentation within terrestrial landscapes. As fragmentation increases, ecotones are created, expanded, and moved, and may play a role in increasing local extinctions (Merriam and Wegner 1992). Building on the basic work of botanists and ecologists in the late 1800s and early 1900s with the tension zone concept, ecologists are examining ecotones more closely to determine their ecological functions and roles in landscapes.

Based upon the earlier understanding of the tension zone concept, ecologists today consider ecotones to be important areas in which to focus studies on changes in ecosystems. The study of ecotones in ecology has been inactive until recently (Rusek 1992). Recent research suggests that ecotones have important functions in landscapes (di Castri et al. 1988, Furley et al. 1992, Gosz 1993,

Hansen and di Castri 1992, Holland et al. 1993, Risser 1995, and Ward and Wiens In Press). These functions include serving as frontiers for successional change (Rusek 1992), governing ecological flows and patterns (Wiens 1997), and preservation of biodiversity (Yoon 1997).

It is important to understand how and why the tension zone concept developed because it is part of one of the major themes in ecology—the search for pattern or distribution in space of species and individuals and understanding their relationships with other organisms and the environment (McIntosh 1976), and understanding change and uniformity within ecosystems (Hagen 1992). This search has been going on since the time of Darwin. In *On the Origin of Species* (1859), Darwin presented the contrasting views of change brought about by the struggle of competition and "a high degree of uniformity, stability, and interdependence" (Hagen 1992) that nature's complex web sometimes produces.

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PREDICTIVE RELATIONSHIPS BETWEEN THE CANOPY OVERSTORY AND THE HERBACEOUS UNDERSTORY IN A NORTHEASTERN WISCONSIN FOREST

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ABSTRACT

The composition of the herbaceous understory can be largely influenced by the dominant canopy tree species. We sampled the herbaceous species composition underlying seven canopy types (eastern hemlock, eastern hemlock-northern hardwood mixture, northern hardwoods, red pine, second-growth disturbed, white cedar swamp, and white pine) from May–July of 2000 in a northeastern Wisconsin forest. We hypothesized that the herbaceous community should predictably differ among canopy types. Significant differences (nMANOVA, $F = 5.02$, $P < 0.001$) existed among the herbaceous compositions. Northern hardwood herbaceous assemblages were the most diverse (55 taxa, $H' = 3.06$, $H_{max} = 4.00$) and white pine assemblages (4 taxa, $H' = 0.95$, $H_{max} = 1.39$) were the least diverse. Discriminant analysis with resubstitution estimates strongly predicted six of seven canopy types from the herbaceous compositions at >85% accuracy; however, cross-validation estimates predicted only two of seven canopy types at >73% accuracy. These data demonstrate that herbaceous community can be used to predict canopy type, at least on an individual habitat scale, in the northeast Wisconsin forest but may lose validity outside this study area.

INTRODUCTION

Woodland ecosystems are complex environments involving biotic and abiotic interactions among light, soils, waters, understory herbaceous plants and shrubs, and canopy trees. Many studies have documented concomitant abiotic influences, rather than interspecific overstory-understory species interactions, that canopy trees have on the composition of underlying vegetation, including soil depth and microtopology (Hicks 1980), structural and habitat dynamics (Auclair & Goff 1971), throughfall precipitation and soil nutrients (Crozier & Boerner 1984), disturbance and resistance (McCormick & Platt 1980; Parker & Leopold 1983; Duffy & Meier 1992), microclimate (Whitney & Foster 1988), biogeography (Schluter & Ricklefs 1993), soil pH (Sagers & Lyon 1997), nitrate availability (Weltzin & Coughenour 1990; Qian et al. 1997), and tree architecture and shade (Berger & Puettmann 2000). Furthermore, other studies demonstrated that

understory community fidelity often appears to be highly individualistic and does not follow an environmental gradient or regional predictive paradigm (Gleason 1926; Curtis 1959; Rodgers 1980; McCune & Antos 1981). Additionally, Kotar et al. (1988; 2002) concluded that vegetation is generally not useful in uniformly categorizing large habitat types, but nonetheless confirmed it to be an important and distinguishing ecosystem characteristic in north temperate forests.

These studies demonstrate the difficulty in explicating unifying herbaceous trends at aggregate species levels across large ecosystems because species often demonstrate a range of tolerances (Curtis 1959). However, because the presence or absence of herbaceous species is governed by interactions of both biotic and abiotic factors, multivariate and ordination techniques could representatively capture these interactions and describe the distribution mosaic at a smaller local or regional habitat-level scale. Such techniques based exclusively on indicator herbaceous species composition, if accurate, would facilitate rapid assessments and dissemination of local and regional forest composition data when other assessment methods are logistically unfeasible.

For our study, we sought to segregate the composite herbaceous understory-canopy overstory relationships in a local forest, at an individual habitat scale, based solely on multivariate analyses of herbaceous species. Portions of Stockbridge-Munsee Mohican tribal forestlands (near Bowler, Shawano County, Wisconsin USA) were lost from reservation control over many decades, resulting in deforestation. Within recent years, these forestlands have been reacquired and managed for restoration. This offered an opportunity to assess the understory-overstory relationships in local tree stands over a large ecosystem with several dominant canopy assemblages, including second-growth restoration areas. We hypothesized, because of the presence of both undisturbed and disturbed tree stands in our study area, herbaceous understory compositions should be markedly and predictably different among each canopy type. Our goal was to generate a multivariate model predicting overstory canopy type from the understory herbaceous composition to demonstrate that the canopy overstory influences the herbaceous understory.

METHODS

Study Area

The Stockbridge-Munsee Mohican tribal forestlands (8747 ha, Bowler, Shawano County, Wisconsin, USA, N 44E 55.5, W 88E 50.5) consist of seven predominant canopy tree assemblages (G. Bunker, unpublished data): eastern hemlock *Tsuga canadensis*, eastern hemlock-northern hardwood mixture, northern hardwoods (sugar maple *Acer saccharum*, red maple *Acer rubrum*, white birch *Betula papyrifera*, beech *Fagus grandifolia*, red oak *Quercus rubra*, and basswood *Tilia americana*), red pine *Pinus resinosa*, second-growth disturbed, white cedar swamp *Thuja occidentalis*, and white pine *Pinus strobus*. Replicate stands of each canopy type are discretely mixed throughout the area. The most common canopy type is northern hardwoods and the most common tree (of 31 recorded species) is the eastern hemlock. The Bureau of Indian affairs has extensively monitored the forestlands and established a continuous forest inventory (CFI) matrix (ca 115 points) referenced with GPS and GIS applications. Each CFI point is equidistant from each other (50 chains) and collectively span the entire forest and all seven canopy types.

Herbaceous Survey

We surveyed 106 CFI locations between May 17 and July 7, 2000. Because we sampled the majority of CFI points within the forest it was not possible to have an equal sample distribution of each canopy type; each canopy type had differing surface areas throughout the study region. However, based on GIS assessments of CFI points per each area unit of canopy type, no canopy types were proportionally underrepresented; each canopy type had approximately the same CFI point : canopy surface area ratio. At each CFI location, we sampled three random 1.0 m^2 quadrats within a 5 m radius of the matrix point and enumerated herbaceous species as stems per m^2 (but considered multiple stem species as one individual when such determinations were possible). We expressed diversity as both total taxa and with the Shannon-Weiner index (Hutcheson 1970).

Multivariate Analyses

To test our hypothesis that understory vegetation should differ among canopy types, we used a three-step multivariate approach following statistical methods in Johnson (1998). We used nonparametric methods throughout our analyses because each canopy type had a different number of CFI points.

1. We used stepwise selection at $\alpha = 0.05$ to choose the most significant indicator herbaceous species (expressed as mean individuals per m^2) used for defining the understory-overstory relationships in the next two steps.

2. We calculated nonparametric multivariate analysis of variance (nMANOVA) from the mean densities of the stepwise-selected plant species of each overstory canopy type using Wilk's likelihood ratio test with a type-III sum of squares at $\alpha = 0.001$. These series of tests allow us to determine if differences exist in herbaceous compositions between canopy types; however, nMANOVA does not *post-hoc* segregate which compositions are different.

3. To determine which of the seven canopy types differed in herbaceous understory composition, we used nonparametric discriminant analysis (DA) with both resubstitution (DA_{RS}) and cross-validation (DA_{CV}) estimates. Mean densities of the stepwise-selected herbaceous species were the independent predictor variables and canopy types were the dependent test variables. Mahalanobis distances between herbaceous vectors were measured from the first nearest neighbor with proportional prior probabilities (prior probabilities were used to account for uneven distribution of CFI points per canopy type).

RESULTS AND DISCUSSION

Herbaceous Survey

We recorded 70 herbaceous taxa throughout the study area (Appendix 1). Wild lily-of-the valley *Maianthemum canadense*, the sedge *Carex pennsylvanica*, and Virginia waterleaf *Hydrophyllum virginianum* were the most commonly encountered species. The other species were patchy and had lower densities. Twelve species were found under only one canopy type: five in northern hardwoods (the grass *Brachyelytrum erectum*, prairie smoke *Geum triflorum*, miterwort *Mitella diphylla*, nettle *Urtica dioica*, and perfoliate bellwort *Uvularia perfoliata*) and seven in white cedar swamps (yellow marsh marigold *Caltha palustris*, pink lady's slipper *Cypripedium acaule*, fragrant bedstraw *Galium triflorum*, royal fern *Osmunda regalis*, wood sorrel *Oxalis acetosella*, fringed milkwort *Polygala paucifolia*, and skunk cabbage *Symplocarpus foetidus*). Subsequently, northern hardwood (55 taxa, $H' = 3.06$, $H_{max} = 4.00$) and white cedar swamp (42 taxa, $H' = 2.50$, $H_{max} = 3.74$) herbaceous assemblages were the most diverse (Table 1). White pine herbaceous assemblages (4 taxa, $H' = 0.95$, $H_{max} =$

TABLE 1. Overstory canopy type, the number of sites sampled, and the diversity of corresponding understory herbaceous species in the Stockbridge-Munsee Mohican tribal forest. Diversity was calculated from the Shannon-Weiner index (Hutcheson 1970). Canopy types are listed in descending diversity order.

Canopy Type	Number of Sites	Number of Taxa	H′	H_{max}
Northern Hardwoods	56	55	3.06	4.00
White Cedar Swamp	10	42	2.50	3.74
Second Growth-Disturbed	12	40	2.57	3.56
Hemlock-Mixed Hardwoods	7	24	2.22	3.18
Eastern Hemlock	15	23	1.86	3.13
Red Pine	4	17	1.54	2.83
White Pine	2	4	0.95	1.39

1.39) were the least diverse. Since the number of species generally increases with area (Connor & McCoy 1979), our observed rare species and diversity indices may be area-dependent. However, we feel that rarefaction estimates are not necessary and that our data proportionally represent all habitats because we sampled a uniform ratio of CFI points per unit area among canopy types.

Multivariate Analyses

Stepwise selection reduced the 70 taxa to 15 significant predictor species (Table 2). Selection removed the ubiquitous wild lily-of-the valley *Maianthemum canadense*, the sedge *Carex pennsylvanica*, and Virginia waterleaf *Hydrophyllum virginianum* while including the infrequently-encountered wood sorrel *Oxalis acetosella* and pink lady's slipper *Cypripedium acaule*. Overall, the

TABLE 2. Significant indicator herbaceous species used for the multivariate nMANOVA and DA techniques. Species were stepwise selected for inclusion at $\alpha = 0.05$. The species are listed in alphabetical order with no reference to statistical significance.

Species
Bunchberry *Cornus canadensis*
Common clubmoss *Lycopodium clavatum*
False solomon seal *Smilacina racemosa*
Goldenthread *Coptis groenlandica*
Large-flower trillium *Trillium grandiflorum*
Long beech fern *Thelypteris phegopteris*
Marsh marigold *Caltha palustris*
Oak fern *Gymnocarpium dryopteris*
Partridgeberry *Mitchella repens*
Pink lady's slipper *Cypripedium acaule*
Sensitive fern *Onoclea sensibilis*
Sessile bellwort *Uvularia sessilifolia*
Sharp-lobe hepatica *Hepatica americana*
Wood anemone *Anemone quinquefolia*
Wood sorrel *Oxalis acetosella*

selection process included patchy species with variable distributions among canopy types that offered a determinant discrimination basis.

Significant differences existed between at least one canopy type and the others according to the 15 significant indicator species compositions (nMANOVA, $F = 5.02$, $P < 0.001$). Moreover, DA_{RS} strongly predicted six of the seven canopy types at >85% accuracy from herbaceous compositions, further demonstrating that herbaceous understory communities differ by canopy overstory type (Table 3). Only the white pine canopy was misclassified, but this error may be expected from low degrees of freedom and discrimination basis. (Only two white pine stands were sampled and had low species diversity. However, to assess any potential sampling bias, after we took our random quatrat samples, we visually inspected the white pine habitat area for any additional herbaceous species we may have not captured, but found none). While DA_{RS} was strong, DA_{CV} was weaker and estimated only two of seven canopy types at >73% accuracy (Table 3). Only northern hardwood mixture and eastern hemlock stands were strongly estimated. This may be due to northern hardwoods having the greatest herbaceous diversity and eastern hemlocks having near the lowest herbaceous diversity.

Our DA models were effective in describing the herbaceous understory-canopy overstory relationships at a habitat scale in the Stockbridge-Munsee Mohican tribal forestlands but lose validity outside our study area. In general, if significant differences exist, DA_{RS} estimates perform strongly with the original data used in creating the rule determinations but may perform weakly with exogenous data (Johnson 1998). Conversely, DA_{CV} is a more rigorous stepwise procedure often used to simulate corroboration with exogenous data. Subsequently, we are confident in our DA_{RS} model estimates within our study area but acknowledge that our DA rules are likely weaker elsewhere.

Our herbaceous understory-canopy overstory results are consistent with other studies (e.g., Gleason 1926; Curtis 1971; Rodgers 1980; McCune & Antos 1981; Kotar et al. 1988; 2002), in that our DA models suggest these patterns are highly individualistic and cannot be generalized from one large region to another. However, our DA models suggest that localized, habitat scale, understory-canopy species-dependent relationships can be demonstrated independently from a suite of measured abiotic correlates (e.g., topology, precipitation, nutrients, shade, etc.). Our study sampled more herbaceous taxa, more forest points, and/or more canopy types than other previous studies that comparatively found less conclusive unifying herbaceous trends (e.g., Hicks 1980; McCune & Antos 1981; Whitney & Foster 1988; Berger & Puettman 2000). Subsequently, the species-DA technique, when derived from a large study area, may facilitate rapid assessment and dissemination of localized, habitat scale, forest composition data when extensive sampling of abiotic metrics is not practical.

TABLE 3. DA estimates of canopy type from herbaceous understory. The row headers represent the actual data and the column headers represent model predictions. The top numbers in each cell represent DA_{RS} model predictions and the bottom numbers in each cell represent DA_{CV} model predictions. The bold-faced percentages along the central diagonal indicate the successful prediction of actual canopy type from the DA model rules derived from herbaceous understory.

Into type → From type ↓ (top = DA_{RS}) (bot = DA_{CV})	Eastern Hemlock	Eastern Hemlock-Hardwoods Mixture	Northern Hardwoods	Red Pine	Second-Growth Disturbed	White Cedar	White Pine
Eastern Hemlock	**100.00%**	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
	73.33%	0.00%	20.00%	0.00%	0.00%	0.00%	0.00%
Eastern Hemlock-Hardwoods Mixture	14.29%	**85.71%**	0.00%	0.00%	0.00%	0.00%	0.00%
	28.57%	**14.29%**	42.86%	0.00%	14.29%	0.00%	0.00%
Northern Hardwoods	7.15%	0.00%	**92.85%**	0.00%	0.00%	0.00%	0.00%
	17.85%	0.00%	**73.21%**	1.76%	1.27%	0.00%	0.00%
Red Pine	0.00%	0.00%	0.00%	**100.00%**	0.00%	0.00%	0.00%
	25.00%	0.00%	0.00%	**0.00%**	75.00%	60.00%	0.00%
Second-Growth Disturbed	8.33%	0.00%	0.00%	0.00%	**91.67%**	0.00%	0.00%
	41.67%	0.00%	58.33%	0.00%	**0.00%**	0.00%	0.00%
White Cedar	0.00%	0.00%	0.00%	0.00%	0.00%	**100.00%**	0.00%
	0.00%	10.00%	30.00%	0.00%	0.00%	**60.00%**	0.00%
White Pine	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	**0.00%**
	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	**0.00%**
Proportional Priors	0.14151	0.06604	0.53774	0.02830	0.11321	0.09434	0.01887

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APPENDIX 1. Herbaceous species list of the Stockbridge-Munsee Mohican tribal forest. An "X" indicates that species was present under that canopy type.

Species	Eastern Hemlock	Eastern Hemlock-Hardwoods Mixture	Northern Hardwoods	Red Pine	Second Growth Disturbed	White Cedar	White Pine
Actaea pachypoda			x				
Adianium pedatum			x		x		
Allium canadense			x				
Amphicarpaea bracteata			x		x		
Anemone quinquefolia	x	x	x		x	x	
Aralia nudicaulis	x	x	x	x	x	x	
Arisaema atrorubens	x		x			x	
Aster macrophyllus	x	x	x	x	x	x	
Asarum canadense			x		x		
Athyrium filix-femina			x		x		
Brachyelytrum erectum			x				
Caltha palustris						x	
Carex pennsylvanica	x	x	x	x	x		x
Carex spp.	x			x	x	x	
Caulophyllum thalictroides	x		x				
Claytonia virginica			x				
Clintonia borealis	x		x	x	x	x	
Convolvulus sepium					x		
Coptis groenlandica			x			x	
Cornus canadensis	x	x	x	x	x	x	
Cypripedium acaule						x	
Dicentra cucullaria			x				
Dryopteris felix-femina				x	x	x	
Dryopteris goldiana		x			x	x	
Dryopteris spinulosa		x	x	x	x	x	x
Equisetum palustre		x					
Equisetum sylvaticum			x				
Equisetum spp.						x	
Fragaria spp.					x	x	
Galium aparine					x	x	
Galium borealis			x		x	x	
Galium triflorum						x	
Gaultheria procumbens			x				
Geum triflorum			x				
Gymnocarpium dryopteris	x		x				
Hepatica acutiloba	x	x	x		x		
Hepatica americana	x	x			x	x	
Hydrophyllum virginianum			x		x	x	
Impatiens capensis			x		x	x	
Lycopodium annotinum		x	x	x	x		x
Lycopodium clavatum	x	x	x		x	x	
Lycopodium complanatum		x	x	x			
Lycopodium lucidulum	x	x	x		x	x	
Lycopodium obscurum	x	x	x	x	x	x	
Lycopodium tristachyum			x				
Maianthemum canadense	x		x	x	x	x	x
Milium effusum			x				
Mitella diphylla			x				
Mitchella repens	x		x	x	x	x	

APPENDIX 1. (Continued).

	Eastern Hemlock	Eastern Hemlock-Hardwoods Mixture	Northern Hardwoods	Red Pine	Second Growth Disturbed	White Cedar	White Pine
Monotropa uniflora			x		x		
Onoclea senibilis			x		x	x	
Osmorhiza claytonii		x	x		x	x	
Osmunda regalis						x	
Oxalis acetosella						x	
Parthenocissus quinquefolia			x		x		
Polygala paucifolia						x	
Polygonatum spp.	x	x	x		x		
Pteridium aquilinum	x		x	x	x	x	
Ribes spp.		x	x	x	x	x	
Sanguinaria canadensis		x	x		x	x	
Smilacina racemosa			x		x		
Solidago spp.			x		x	x	
Symplocarpus foetidus						x	
Taraxacum officinale			x			x	
Thelypteris phegopteris		x	x			x	
Trientalis borealis	x	x	x	x	x	x	
Trillium grandiflorum	x	x	x		x	x	
Urtica dioica			x				
Uvularia perfoliata			x				
Uvularia sessilifolia	x	x	x		x	x	
Viola spp.	x	x	x	x	x	x	

REVIEW

Czarapata, Elizabeth J.† 2005. Invasive Plants of the Upper Midwest. An Illustrated Guide to their Identification and Control. University of Wisconsin Press, 1930 Monroe Street, Madison, Wisconsin 53711; www.wisc.edu/wisconsinpress/ ISBN 0-299-21054-5; xx + 215 pages; paperback, $26.95; ISBN 0-299-21050-2, cloth, $60.00.

The intended coverage of this fine new book is nearly that of our journal, east to Ohio, and including also Iowa and Missouri. The cover photograph (on the paperback version at hand) shows a solid understory of garlic mustard, *Alliaria petiolata* (Brassicaceae) in a woodland. There is no caption for the photograph (and the photo is not repeated inside), but the author and her book designer surely deemed one unnecessary—this has become an all-too-familiar sight in this part of the world.

That invasive species have a large economic impact may not be self-evident, and for that reason, the point is made repeatedly throughout the text. There are also deleterious effects on wildlife: degradation of grazing areas for elk further west; monarch butterflies adversely affected by ovipositing on swallow-wort (*Vincetoxicum*, Asclepiadaceae), though no literature citation is given; and some fascinating interactions between birds and weedy *Lonicera* as given on page 32.

One of the most useful features of the book is the extended treatment of various herbicides that are available. Application methods are also given in considerable detail. (Alas, all the wasted hours spent spraying diluted Roundup on the leaves of buckthorn! This book tells you how to do it, and do it right.) The subject of how long seeds of various species may survive in the soil is repeatedly mentioned.

It's a common notion that the troublesome invaders in many ecosystems are all introductions from the Old World. The author does not fall into this error, and devotes an entire chapter to native plants that sometimes need control.

There is a very ample index. But indexers always make decisions, and sometimes the results can be troubling. For example, the monarch butterfly didn't make it into the index (not listed under "butterflies," either), so that you can't readily get back to the story referred to above. It's on page 132. There are some minor misspellings, like *Cirsium miticum* (for *muticum*), but they won't trouble anyone.

There are no keys. That would not have been practical in a book of this nature. The color photographs and lengthy descriptions will suffice for nearly all users. There are, according to the blurb on the UW Press website, 262 color photographs and 20 drawings.

One regrets that the author (b. 1950- d. 2003) did not live to see her fine book in print. The work is a most fitting memorial.

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EFFECTS OF CONTROLLED BURNS ON VEGETATIVE GROWTH AND SEXUAL REPRODUCTION IN VALERIANA CILIATA IN A MICHIGAN FEN

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ABSTRACT

Valeriana ciliata T. & G. is a perennial plant restricted in Michigan to a small number of fens. A variety of management practices, including prescribed burns, is being used to control the establishment of alien woody species in fens. Response of *V. ciliata* to early spring burning was studied by examining plants in burned and unburned plots within a fen in southeastern Michigan. Neither growth, estimated as total number of leaves, number of rosettes and number of leaves per rosette, nor flowering, estimated as the proportion of plants flowering within quadrats, exhibited changes that could be attributed to burn treatments over the four year study. Early spring burning, therefore, can be employed as a management tool to control invasion of the fen by woody plant species without adversely affecting *V. ciliata*.

INTRODUCTION

Fire is an ecological factor that can induce a diverse array of responses at the individual, population and community levels of organization (Whelan 1995). Plant growth and reproductive effort can increase (Engle et al. 1998; Lamont & Runciman 1993; Singh 1993; Towne & Knapp 1996), decrease (Towne & Knapp 1996), remain unchanged (Grilz & Romo 1994; Towne & Knapp 1996) or stimulate shifts in allocation within plants (Brewer 1999; Johnson & Matchett 2001) in response to burning, although different populations of a species may vary in their response to burning (Brewer 1995), particularly when soils or topographic position differ (Engle et al. 1998). Initial responses of plants to fire may decrease in subsequent years (Pendergrass et al. 1999). Plant populations may increase (Johnson & Knapp 1995), decrease (Arthur et al. 1998; Johnson & Knapp 1995), or remain unchanged following burning (Howe 1995; Rooney et al. 1992). Interactions among post-fire changes may complicate analyses of plant response to burning (Briggs & Knapp 1995; Menges & Kimmich 1996).

When management goals include the maintenance of habitats that support fire-adapted or fire-neutral rare species, controlled burning may be an effective means of both maintaining those rare species and reducing the density of "undesirable" species. Species' reactions to burning are highly individualistic; therefore, before fire can be used as an effective management tool, responses to fire by each species of interest must be studied in detail. Ideally, community-level re-

sponses to prescribed burning should be studied, particularly when unusual or rare habitats are involved.

In Michigan, fen habitats are uncommon. Consequently, species restricted to fen habitats are similarly scarce and are at risk of extinction if fens are overrun by invasive species, particularly woody species. Highland Cemetery Fen (in Ypsilanti, Michigan) and adjacent upland habitats support a diverse and dynamic flora that has been studied for many years (Brown 1905; Ohlsson 1970). *Valeriana ciliata* T. & G. (Valerian) grows in the fen with a variety of other typical fen species. The fen is currently managed by the Michigan Chapter of The Nature Conservancy to preserve its diversity. The primary threat to survival of the fen ecosystem is encroachment of the margin of the fen by alien woody species, primarily glossy buckthorn (*Rhamnus frangula* L.) (D. Ewert pers. comm.). Several management techniques designed to control invading alien species have been used, including cutting, herbicide application to stumps, and burning. Before fire can be used as a long-term management tool for this fen, the effects of fire on growth and reproduction (flowering) of *V. ciliata* must be investigated. This paper presents results of a study designed to test the hypothesis that early spring burning of the fen will affect growth or flowering of *V. ciliata*.

Valeriana ciliata occurs from Ohio and southern Ontario to Minnesota and Iowa and is closely allied to *V. edulis* Nutt. *Valeriana ciliata* is an herbaceous species that perennates in the form of a stout taproot and rhizome at, or slightly below, the surface of the soil. The rhizome branches as the plant grows, and each year it may produce a rosette of vegetative basal leaves on each branch. *Valeriana ciliata* produces opposite leaves usually at 2 to 4 nodes in a basal rosette. Some rosettes produce small lateral shoots in the axils of basal leaves, yielding much higher leaf counts for such rosettes. A flowering shoot produces an erect stem with one or two pairs of opposite, pinnately divided cauline leaves near its base. Leaves emerge above ground in early April, flowers mature in May and fruits mature by June. Rosettes produced by a plant remain connected by a discernible rhizome branch. Approximately 25% of plants in the population flower in a given year. *Valeriana ciliata* is reported to be polygamo-dioecious (Gleason & Cronquist 1991).

Growth and reproduction (both sexual and vegetative) are constrained by plant morphology (Waller 1988; Watson 1984). Perennial plant species are known to exhibit a range of growth and reproduction responses to changes in environmental conditions and aging (Andersson & Widen 1994; Braun & Toth 1994; Falinska 1995; Miller & Fowler 1994). Consequently, environmental changes within a habitat, including disturbances such as fire, may lead to significant differences in growth, vegetative reproduction and sexual reproduction in long-lived perennial plant species capable of vegetative reproduction. I hypothesize that *V. ciliata* will exhibit altered vegetative growth and flowering behavior following spring burning treatments.

METHODS

Highland Cemetery Fen is located at the base of a south-facing bluff at the south edge of the cemetery near the Huron River in Ypsilanti, Washtenaw Co., Michigan. Groundwater seepage from

the base of the bluff provides a constant supply of water to the fen. The slope of the fen faces approximately south and slopes downward by approximately 3 m to a wetter portion that does not support *Valeriana ciliata* plants. Glossy buckthorn currently is not in the *V. ciliata* population.

In April 1986 (prior to this study) the western half of the fen was burned prior to emergence of *V. ciliata* in an effort to reduce the density of glossy buckthorn before *V. ciliata* shoots emerge from the soil. In spring 1987, eight transects measuring from 10 to 30 m were established parallel to the slope of the fen at 5 m intervals, starting near the base of the bluff. Transect length was determined by the distance across the population of *V. ciliata* at each transect. Twenty eight 1×2 m quadrats were established at 7 m intervals along each transect, with the long axis of each quadrat oriented perpendicular to the axis of the transect. Transects contained from two to six quadrats each. The area burned in 1986 contained 12 quadrats on 3 transects and the unburned area contained 16 quadrats.

In April 1989 the southern half of the population was burned before *Valeriana* plants emerged, yielding a total of four different burn treatment areas: not burned (10 quadrats), burned in 1986 only (6 quadrats), burned in 1989 only (6 quadrats) and burned in both 1986 and 1989 (6 quadrats).

In May of each year, *Valeriana ciliata* plants were located in 10 by 10 cm grids overlaid on each quadrat and positions of all individuals were marked on scaled drawings of quadrats to allow identification of individuals from year to year. Because destructive sampling of this rare species was not permitted at this site, estimates of plant size were limited to the following dependent variables: total number of leaves per plant, number of rosettes per plant and number of leaves per rosette per plant (excluding cauline leaves of flowering rosettes). Leaf length and width were measured in 1987, but leaves continued to grow during the growing season, so they were not measured after 1987. Below ground structures could not be measured. Sexual reproduction in the population was estimated as the proportion of plants in flower within quadrats.

Data were analyzed in two stages. Initial evidence of the effects of the 1986 and 1989 burns was obtained from three-way ANOVAs using presence or absence of a burn in 1986, presence or absence of a burn in 1989, and sampling year (1987 through 1990) as independent variables and plant size characteristics as dependent variables. Plant flowering response was measured as the proportion of genets in flower per quadrat. Those data were arcsine-transformed to reduce the correlation between means and variances. Means and standard errors were back-transformed before reporting the results. A three-way ANOVA was applied to flowering data using the same design as for plant size.

All quadrats within a given burn treatment were located in the same area of the population because of the previously established burn pattern. Inherent differences in conditions in the four areas of the population, rather than differences induced by burn treatments, might be responsible for any significant differences suggested by the three-way ANOVAs. Such habitat differences could confound interpretation of results of the three-way ANOVAs and lead to falsely interpreting differences between burn treatment areas to burn effects rather than to other environmental factors associated with different parts of the site. In addition, pseudoreplication, an unavoidable design component of most studies of this kind, imposes limits on the confidence with which we accept our conclusions.

A more direct, although statistically less informative approach than the three-way ANOVA, was to test for differences in the annual change in size of individual plants between years using two sets of quadrats: those that had not been burned, and those burned only in 1989. The two-way ANOVA used change in plant size as the dependent variable with sampling year interval and burn treatment as independent variables. A difference in amount of annual change in plant size following a burn without a similar difference observed in the unburned quadrats would suggest an effect of burning on plant growth. The annual change in each plant characteristic was calculated for two independent periods: May 1987 to May 1988 (i.e., value for 1988 minus value for 1987) and May 1989 to May 1990. The burn treatments occurred in April of 1986 and 1989. The 1988 to 1989 period could not be used as an additional, independent measure of response to burning because it would require data from the same years as were used in the 1987 to 1988 and 1989 to 1990 period and, therefore, would not be a statistically independent measure of plant response. Only those plants present in successive years could be used to calculate change in plant size. Consequently, the change in average plant size between years (as tested using the three-way ANOVA) is not the same as the average change in individual plant size between years (as tested using the two-way ANOVA). A significant sampling year effect would not indicate a burn response by the plants. A significant burn treatment effect would not provide conclusive evidence of a burn effect on plant growth because the burned and unburned quadrats occur in different parts of the site (differences in site characteristics and burn treatment might be correlated). A significant interaction between time interval and burn treatment in the two-

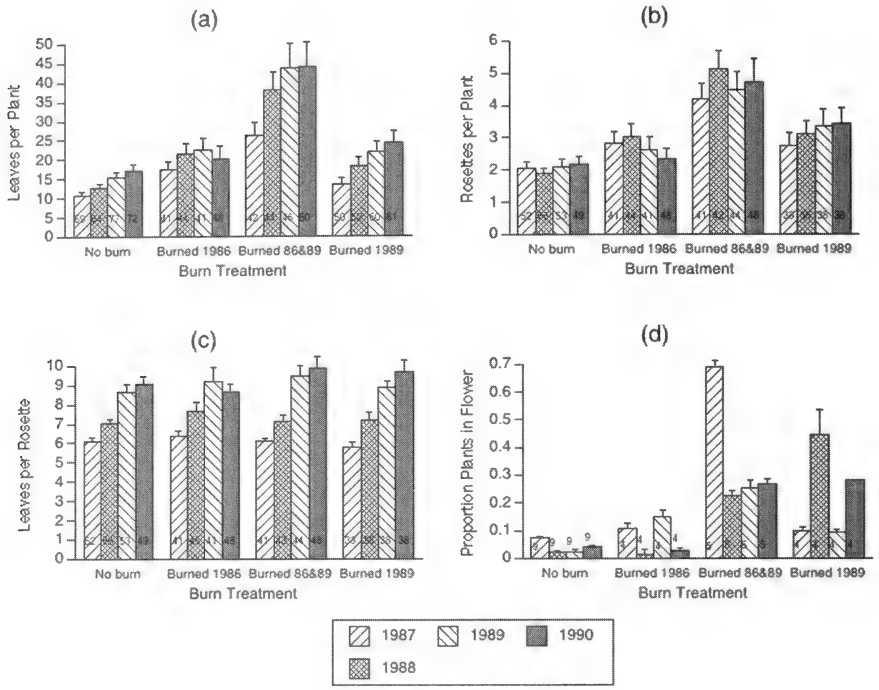

FIGURE 1. Plant size and flowering characteristics in each of four years in four treatment areas at Highland Cemetery: not burned, burned in 1986 only, burned in both 1986 and 1989 and burned in 1989 only. Bars represent means + 1 SE; sample size shown at bottom of bars. (a) number of leaves per plant; (b) number of rosettes per plant; (c) number of leaves per rosette per plant; (d) proportion of plants in flower per quadrat

way ANOVA would indicate an effect of burning on plant growth and flowering because the change in plant size between years would be influenced by burn treatment.

RESULTS

The three-way ANOVA that examined total number of leaves per plant revealed a significant interaction between 1986 and 1989 burn treatments ($P < 0.001$), but no significant interactions with year ($P = 0.141$ and $P = 0.687$ for interactions between year and 1986 burn and 1989 burn treatments, respectively). In three of the four burn treatment combinations, total leaf number increased each year (Fig. 1a). Increases in leaf number were observed in 1989 and 1990 whether plots were burned in 1989 or not. A similar pattern of change in leaf number was found in plots following the 1986 burn compared with plots not burned in 1986 (Fig. 1a).

The number of rosettes per plant differed among burn treatment areas. The unburned portion of the population had lower means each year than the other

treatment combinations, whereas the part of the population burned in both years had higher means than the other three areas (Fig. 1b). No significant interaction between year and burn treatment was found, however. The only significant interaction indicated in the three-way ANOVA was a two-way interaction between 1986 and 1989 burn treatments ($P = 0.046$).

The number of leaves per rosette showed no consistent relationship between year or presence or absence of a burn in 1986 or 1989. No significant three-way or two-way interactions were detected by the three-way ANOVA. Overall, mean number of leaves per rosette differed significantly by year. Mean leaf number per rosette increased in each successive year in all four burn treatment combinations except one (Fig. 1c). A slight decrease from 1989 to 1990 was found in the plants burned only in 1986.

The proportion of flowering plants per quadrat showed no three-way interaction between burn treatments and year effects ($P = 0.123$). One significant two-way interaction was found between the 1986 burn treatment and year ($P = 0.024$). The data showed differences between years in quadrats burned in 1986 and not burned in 1986, with higher means overall in the burned quadrats, although the highest mean values were not always in years immediately following the 1986 burn (Fig. 1d). For example, the highest proportion of flowering plants per quadrat was 0.689, obtained in 1987 in quadrats that were burned in 1986 and again in 1989. In the quadrats burned only in 1986, the 1987 mean was not the highest value among years in that group. Likewise, the year following the 1989 burn was not significantly higher than the year preceding the burn for quadrats burned in only 1989 or burned in both 1986 and 1989. The pattern of flowering response does not consistently correspond with the pattern of burning.

Results of the two-way ANOVA of annual change in plant size and flowering showed no significant interaction between time interval and the 1989 burn treatment for total leaf number per plant ($P = 0.493$; Table 1; Fig. 2a), number of rosettes per plant ($P = 0.613$; Table 1; Fig. 2b), number of leaves per rosette

TABLE 1. Change in plant growth and flowering between 1987 and 1988 and between 1989 and 1990 in the 1989 burn treatment area [mean + se (n)]

		Burned in 1989?	
Change in:	Growth interval	No	Yes
Leaves per plant	1987–1988	0.88 + 0.69 (68)	4.74 + 1.27 (50)
	1989–1990	0.05 + 0.90 (63)	2.31 + 1.85 (48)
Rosettes per plant	1987–1988	–0.12 + 0.13 (52)	–0.09 + 0.13 (53)
	1989–1990	0.24 + 0.21 (38)	0.08 + 0.26 (38)
Leaves per rosette	1987–1988	1.12 + 0.19 (52)	1.43 + 0.32 (38)
	1989–1990	–0.30 + 0.57 (53)	0.87 + 0.40 (37)
Proportion of plants in flower	1987–1988	–0.06 + 0.04 (9)	0.28 + 0.24 (4)
per quadrat	1989–1990	0.02 + 0.04 (9)	0.16 + 0.09 (4)

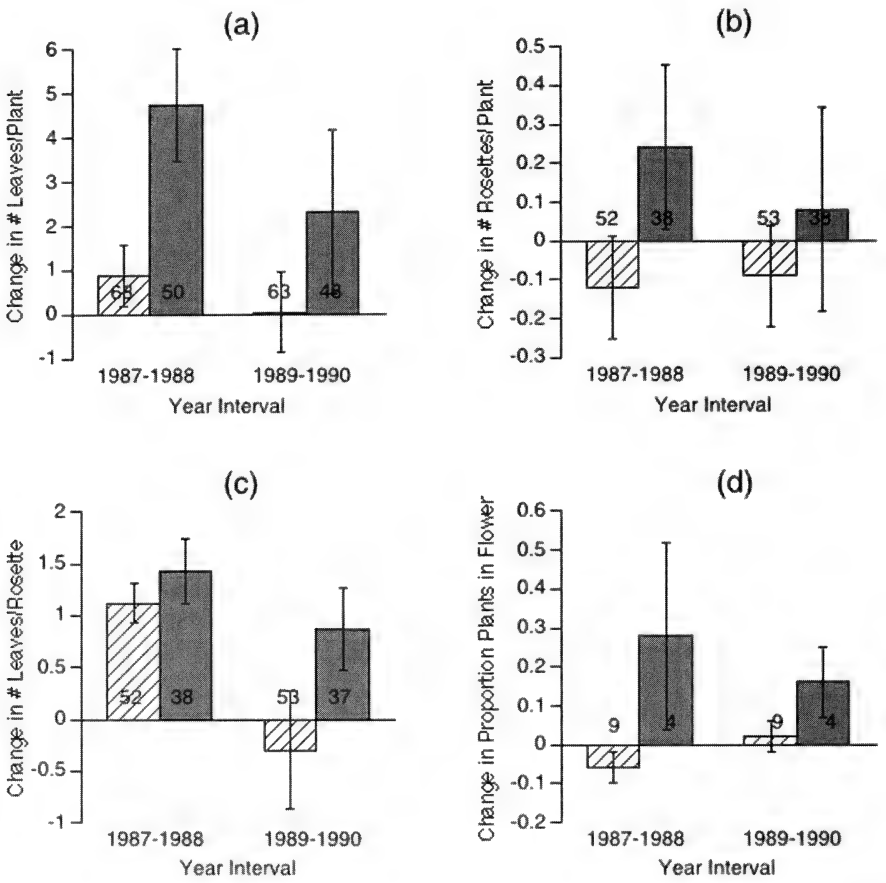

FIGURE 2. Change in plant size and flowering between 1987 and 1988 and between 1989 and 1990 in two treatment areas at Highland Cemetery: not burned (hatched bars) and 1989 burn (gray bars). Bars represent means + 1 SE; sample size shown at bottom of bars. (a) change in number of leaves per plant; (b) change in number of rosettes per plant; (c) change in number of leaves per rosette per plant; (d) change in the proportion of plants in flower per quadrat

(P = 0.302; Table 1; Fig. 2c), or proportion of flowering plants per quadrat (P = 0.284; Table 1; Fig. 2d).

The burn treatment effect on total leaf number (i.e., burned in 1989 vs. not burned in 1989) was significant (P = 0.009) because both 1987–1988 and 1989–1990 time intervals had mean changes in leaf number that were much higher than for the unburned quadrats (Table 1; Fig. 2a).

The direct comparison of change in number of rosettes per plant over the 1987–1988 and 1989–1990 time intervals by two-way ANOVA revealed no significant effects attributable to either burn treatment (p = 0.139) or to time interval (P = 0.699) (Table 1; Fig. 2b).

The change in number of leaves per rosette showed a significant effect of growth interval (1987–1988 vs. 1989–1990) (P = 0.02), but not burn treatment (burned vs. not burned in 1989). The 1987–1988 interval produced greater growth than in the 1989–1990 interval in both the burned and unburned quadrats (Table. 1; Fig. 2c).

Those quadrats chosen for burning in 1989 had a greater change in proportion of rosettes flowering than did quadrats not chosen for burning in 1989, regardless of sampling period (P = 0.016; Table 1; Fig. 2d).

DISCUSSION

The goal of this study was to determine whether fire can be used as a management tool to protect fens in Michigan from encroachment by invasive glossy buckthorn without adversely affecting growth and flowering of *Valeriana ciliata*. Results of this study indicate that controlled burning of this fen in early spring, before *V. ciliata* emerged from the ground, had no adverse effects on either above-ground vegetative growth or flowering of *V. ciliata*.

Differences in plant size from years before a burn to years following a burn suggests an effect of burning on plant growth, but closer inspection reveals the fallacy of that conclusion. The lack of statistical interaction between year and burn treatment indicates that burning was not associated with differences between mean leaf number per rosette, number of rosettes per plant, or total number of leaves per plant. Yearly changes in plant size occurred in both burned and unburned quadrats, and occurred in quadrats prior to burning (Fig. 1). Factors other than burning must have induced plants to grow to different sizes between years. Other studies of plant responses to burning have shown that successional stage (Engle & Bidwell 2001), associated plant cover (Tyler & Dantonio 1995), and time since burning (Pendergrass et al. 1999; Quintana-Ascencio et al. 1998) can affect plant growth in burned areas. Under some circumstances, therefore, effects of burning may be overriden by other factors, including those that vary within a site. In this study, *Valeriana* plants in different treatment areas of the population differed in size before the 1989 burn, suggesting that habitat differences promoted different growth patterns in the absence of fire.

A much more sensitive measure of plant response to burning should be possible by comparing changes in growth by plants in the same quadrats from one year to the next. By comparing parallel changes in growth between plants in unburned quadrats to changes in plants in burned quadrats, using years that span a burn year, effects of annual fluctuations in growth conditions may be reduced. If burning has an impact on growth, one would expect to see significant differences in growth (change in plant size between years) before as compared to after burning, and those differences should not be found in the unburned quadrats; i.e., a significant interaction between annual growth and burn treatment should be found. The lack of such interaction suggests that burning has no effect on plant growth.

The lack of detected changes in vegetative growth in this study is consistent

with responses of some prairie forbs (e.g., *Dalea candida*, *D. purpurea*, *Desmodium illinoense*, *Lespedeza capitata*, *L. violacea*, *Psoralea tenuiflora*, *Schrankia nuttallii*) to April burn treatments (Towne & Knapp 1996). Those species exhibited similar biomass in sites that were burned annually vs. unburned sites, but overall effects of fire on plant growth can include changes in the ratio of above-ground to below-ground biomass, even if total plant biomass does not change (Brewer 1999). Nondestructive measures of above ground plant growth were required in this study of *Valeriana ciliata*, however, so partitioning of growth between structural components was not possible.

Some herbaceous perennials are induced to flower after a burn (Kettle *et al.* 2000; Kirkman et al. 1998; Lamont & Runciman 1993). Flowering of *Valeriana ciliata*, measured as percent of plants in flower per quadrat, was highly variable among quadrats. Higher proportions of flowering plants in the 1989 burn and 1986/1989 burn quadrats might suggest a burn effect; however, both high and low proportions of flowering plants occur prior to burning in the 1989 burn treatment. Flowering was low in the year of the burn in the 1989 burn treatment and rose the year following the burn, but no increase in flowering was observed in those same years in the quadrats burned in both 1986 and 1989 (Fig. 1d). Different patterns of flowering were found in different parts of the population, regardless of burn treatment, suggesting that burning did not effect the likelihood of flowering in *V. ciliata*.

A persistent theme in the analyses of growth and reproduction in this population is the overriding importance of habitat characteristics in determining growth and flowering behavior of *Valeriana ciliata*. Fire, at least at the intensities and season pertinent to this study, had no discernible effect on either plant growth or flowering. The diversity of plant responses to burning reported in the literature suggests that species exhibit individual responses to fire and that differences in fire characteristics (windspeed, temperature, litter depth, relative humidity, moisture content of fuel, etc.), in addition to season, combine to influence plant growth following fire (Bond & vanWilgen 1996; DeBano et al. 1998; Whelan 1995). Many aspects of the response of *V. ciliata* to fire were not addressed in this study, such as inflorescence size, number of rosettes in flower per plant, fruit set, seed germination, seedling establishment, or nutrient status of plants. All of these are potentially important to the long-term survival of the population, but at the gross level of plant size and flowering, burning in early spring has little effect on *V. ciliata*. Prescribed burning in early spring, therefore, is a useful management tool that can be used without harming adult *V. ciliata* plants.

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COREOPSIS TRIPTERIS L. (ASTERACEAE) IN WISCONSIN

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The genus *Coreopsis* (Asteraceae) includes approximately 100 mainly New World species. Of these, four occur in Wisconsin, though for over a century a fifth (*Coreopsis tripteris* L.) has been ascribed to the state, without a supporting voucher. The claim that this species occurs in Wisconsin appears to have arisen in Gray (1884), wherein he included Wisconsin in his range statement; since then, the "report" has been faithfully copied.

The species is reported for Mitchell Glen, a site in Green Lake County, Wisconsin, by Tracy (1889). Mrs. C. T. Tracy, Instructor in Botany at Ripon College, self-published a pamphlet on the flora of Ripon (Fond du Lac County, Wisconsin). The thing is notable for numerous misspellings and very unusual "records," such as *Pinguicula vulgaris* (Lentibulariaceae). Unfortunately, her herbarium is no longer extant at Ripon College; a goodly number of her duplicates somehow found their way to the Lawrence University herbarium, now incorporated into OSH, but there is no specimen of any *Coreopsis* included. The matter is treated further in Eddy (1999).

The first voucher for *C. tripteris* from Wisconsin was collected by Patrick Robinson, Northeast Region Ecologist with the WDNR's Bureau of Endangered Resources, on 10 September 2004. Robinson discovered a small dry-mesic remnant prairie approximately 9 miles northwest of Oshkosh within the west right-of-way of U.S. highway 45 in Winneconne Township, SE ¼ NE ¼ NE ¼ section 2, T19N, R15E; the voucher is Robinson *s.n.*, WIS. Robinson offered these observations of *C. tripteris* at the site:

> In a remnant dry-mesic prairie. The dry-mesic prairie is approximately two acres in total size with some areas showing evidence of significant disturbance. The surrounding land is being used for agriculture. Dominant associates included *Aster oolentangiensis, Liatris aspera,* and *Aster ericoides*. Additional associates included *Euphorbia corollata, Melilotus alba, Melilotus officinalis, Helianthus occidentalis, Rhus glabra, Monarda fistulosa, Andropogon gerardii, Panicum virgatum, Vitis riparia, Daucus carota, Bromus inermis, Asclepias verticillata, Rosa blanda, Ratibida pinnata,* and *Cirsium vulgare* (Wisflora, 2005).

In addition to Robinson's list, these species were observed by T. L. Eddy, T. G. Lammers, and N. A. Harriman on two different visits to the site in late August and early September 2005: *Schizachyrium scoparium, Bouteloua curtipendula, Dalea purpurea, Geum triflorum, Helianthus grosseserratus, Isanthus brachiatus, Ruellia humilis, Silphium integrifolium, S. laciniatum, S. terebinthinaceum, Solidago rigida,* and *Verbena simplex*. It is worth noting that *R. humilis* is a Wisconsin endangered species and *V. simplex* is listed as Special Concern. The small population of *Silphium integrifolium* occurs on the east side of the

FIGURE 1. Flowering heads of *Coreopsis tripteris*, 13 September 2005, photograph by the author.

highway, but still within the right-of-way. The voucher for *Coreopsis tripteris* in 2005 is *Harriman & Lammers s.n.*, 30 August 2005, OSH and WIS. Winnebago County, Wisconsin, has been very thoroughly botanized over the past four decades (see, for example, Rill 1983). Nonetheless, the site yielded four new county records: *Coreopsis tripteris, Ruellia humilis, Verbena simplex,* and *Silphium integrifolium.* (It should be noted that on maps more than a year old, the present U.S. 45 is labelled as state route 110; the original, older U.S. 45 is now state route 76.)

Coreopsis tripteris is the tallest and latest flowering *Coreopsis* in Wisconsin, blooming from late August through early September (Figs. 1 & 2). It is an erect perennial forb arising from short, stout rhizomes that produce glabrous to glaucous stems 3–9 feet tall. The mainly cauline trifoliolate leaves are numerous with the leaflets lanceolate or narrowly elliptic, 5–10 cm wide by 6–25 cm long. The inflorescence is comprised of numerous heads with disks approximately 1 cm diameter that gradually change from yellow to purplish or dark red. Yellow ray flowers are 1–2.5 cm long (Figure 3). Achenes are obovate, 4–7 mm; each achene is accompanied by a pappus of a few minute erect bristles. (Gleason & Cronquist, 1991).

The soil type of the *C. tripteris* site in Winnebago County is classified as RhC2—Ritchey silt loam, 6 to 12 percent slopes, eroded (United States Department of Agriculture 1980). According to the soil survey the " . . . soil is sloping and is on narrow ridgetops and side slopes in areas where dolomite is at a shallow depth." In fact, scattered flat outcrops of Prairie du Chien dolomite, Ordovician bedrock, in the highway right-of-way are partially covered with a "biological soil crust" (Neher et. al., 2003). Elsewhere a thin mantle of well-drained loam underlies dry-mesic prairie.

The original land survey of interior section lines for T19N and R15E began on 30 March 30 1839 and was completed on 3 April 1839 (Wisconsin public land survey records: original field notes and plat maps, 1839). A summary from the township field notes prepared by surveyor D. Giddings provides a description of the landscape and vegetation cover that includes the dry-mesic prairie relict where *C. tripteris* occurs:

> The foregoing township is mostly oak openings well timbered with large Br. [bur] Oak. The land is high & dry, slightly rolling; soil is a warm yellow loam, a great part of it having the appearance of having been formerly planted by the Indians. The Prairie [Fig. 4] in sec 1 & 12 is dry and rich.

Thus, in spite of its small area and past disturbance, this roadside relict is a native grassland "island" worthy of management and protection by local and state agencies.

It is conceivable that *Coreopsis tripteris* in Winnebago County represents an overlooked disjunct population that is part of Wisconsin's original vegetation cover. Circumstantial evidence includes: 1) the plant is established on an original dry-mesic prairie remnant and is unlikely to have been deliberately planted there, within the right-of-way of a busy highway, and 2) in spite of past disturbance, a diverse flora that includes rare species and common associates is present at the site. Contrarily, the plant might be adventive from seed from local

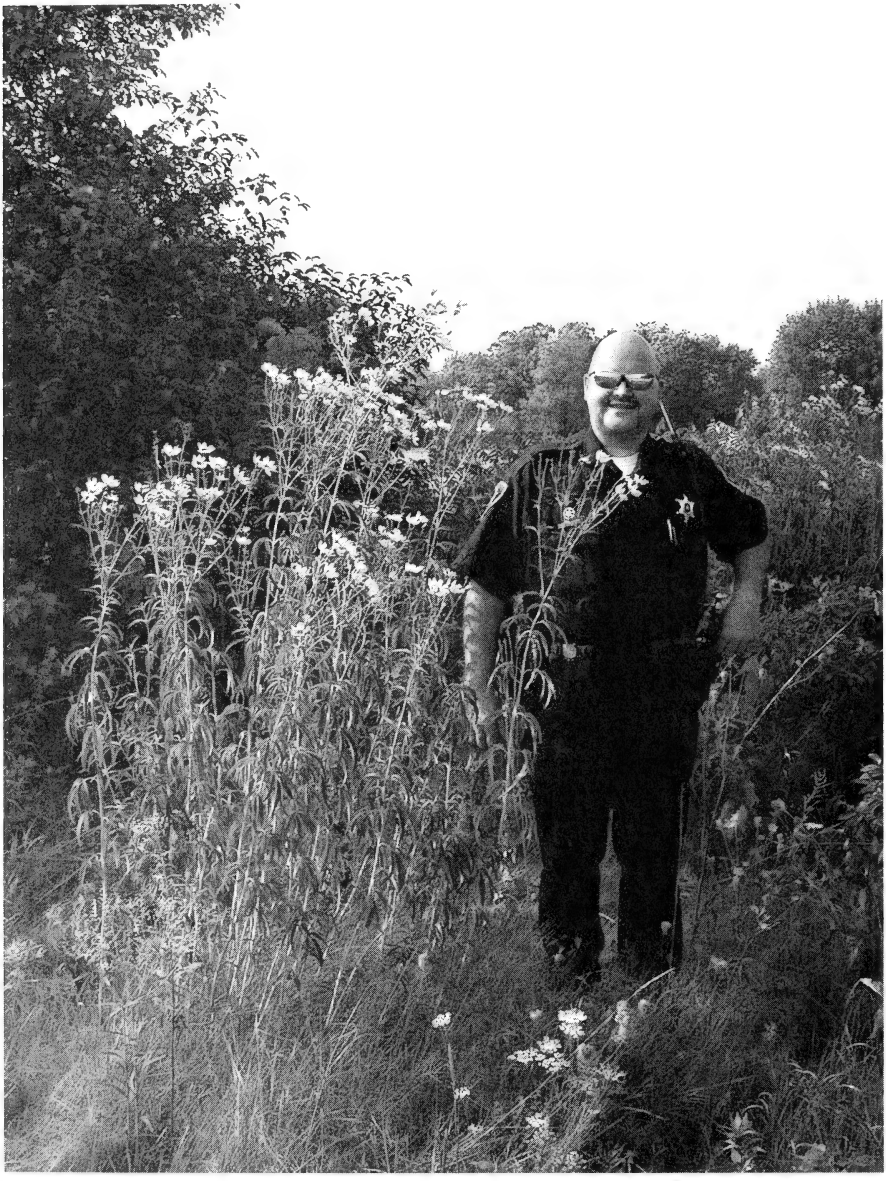

FIGURE 2. Local population of *Coreopsis tripteris*. Winnebago County Deputy Sheriff Craig Cook, six feet tall, had stopped along the road shoulder to offer help and assistance, if needed, and kindly agreed to pose with the plants to provide scale; 13 September 2005, photograph by the author.

FIGURE 3. Closeup of a flowering head of *Coreopsis tripteris*, 13 September 2005, photograph by the author.

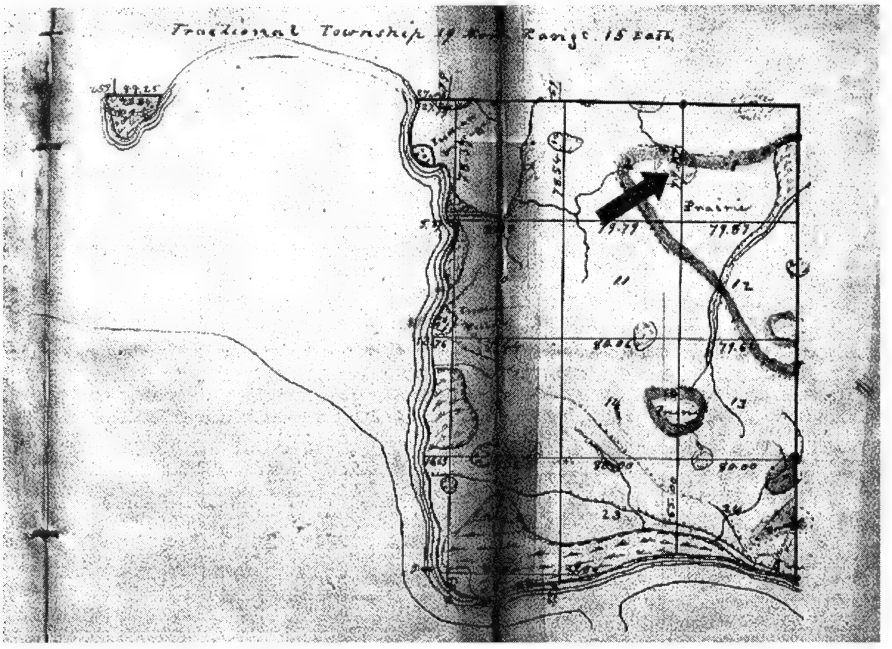

FIGURE 4. A page from the original land surveyor's notes, showing that the present site was a prairie in 1839.

prairie restoration/horticultural plantings. For example, an Internet search for "*Coreopsis tripteris* seed+price" resulted in 306 links (0.27 seconds)—testimony to the ready availability of *C. tripteris* seed for sale commercially. Moreover, there is a specimen of this species in OSH from the donated private herbarium of Katherine Dorney Rill, dating from 1978, where the collector indicates the plant came up in her Oshkosh garden as a contaminant with some other seed she had planted. The possibility of "horticultural contamination" cannot be excluded.

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Gleason, H. A. & A. Cronquist. 1991. Manual of Vascular Plants of Northeastern United States and Adjacent Canada. New York Botanical Garden, Bronx, NY.

Gray, Asa. 1884. Synoptical Flora of North America. Vol. 1, part II, Caprifoliaceae—Compositae. (*Coreopsis tripteris*, p. 294.)

Neher, D. A., T. L. Walters, E. Tramer, T. R. Weicht, R. M. Veluci, K. Saiya-Cork, S. Will-Wolf, J. Toppin, J. Traub & J. R. Johansen. 2003. Biological soil crust and vascular plant communities in a sand savanna of northwestern Ohio. Journal of the Torrey Botanical Society 130(4): 244–252.

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Tracy, C. T. 1889. Catalogue of plants growing without cultivation in Ripon and the near vicinity.

Self-published pamphlet, an original copy in the holdings of the Wisconsin State Historical Society, a photocopy in OSH and elsewhere.

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Wisflora: Wisconsin vascular plant species. 2005. Retrieved 13 September 2005, from Wisflora: Wisconsin Vascular Plant Species Web site: http://www.botany.wisc.edu/wisflora/.

Wisconsin public land survey records: original field notes and plat maps. 1839. Retrieved 17 September 2005, from http://digicoll.library.wisc.edu/cgi-bin/SurveyNotes/SurveyNotes-idx?type=article&byte =5993853&twp=T019NR015E.

ANNOUNCEMENT

Additions and Corrections to *Gleason's Plants of Michigan,* revised by Richard K. Rabeler of the University of Michigan Herbarium. Oakleaf Press, November 1998. Trade paper, 4?″ × 8″, 398 pages; weight, 1 lb; binding: sewn signatures with Kivar® water-and tear-resistant cover. ISBN: 0-9663251-0-9. LCCN: 98-67416. Retail Price: $24.95

This one-volume field guide to plants of Michigan and the Great Lakes uses the nomenclature and family arrangement of E.G. Voss' definitive series, *Michigan Flora*, with synonyms from Gleason and Cronquist's *Manual of Vascular Plants of Northeastern United States and Adjacent Canada.* The structure of the keys follows the classic *Plants of Michigan* by H.A. Gleason, but keys and plant treatments have essentially been rewritten and are supplemented by a section on botanical terminology, a glossary, and full index.

Given here are additional corrections since the appearance of the 2nd (corrected) printing, February 2001. These are based on field tests of the keys. Future updates can be found at www.oakleaf-press.com, as is ordering information. Users of the book are invited to send further comments to the publisher at oakleaf@provide.net.

Page	Key	Additions/corrections
20,121,127, 165, 226,227, 237, 254,262	various	These are all references to the Michigan "Christmas tree law" that prohibited removal of several wild plants from private property without permission. This law has been repealed..
55	Woody Plants	Line 89b. should lead to new couplet 89.5
55	Woody Plants	Add new couplet between 89 and 90: 89.5a. Leaves covered with silver or silver and brown scales beneath—***Elaeagnus*** spp., in ELAEAGNACEAE, p.240 89.5b. Leaves lack silver or silver and brown scales beneath—90
56	Woody Plants	Line 109a. should lead to new couplet 109.5
56–57	Woody Plants	Add new couplet between 109 and 110: 109.5 a. . Leaves covered with silver or silver and brown scales beneath—***Elaeagnus*** spp., in ELAEAGNACEAE, p. 240 109.5b. Leaves lack silver or silver and brown scales beneath—110
58	Woody Plants	Line 125b. should lead to line 127. Line 127b. should lead to line 128.
70	Dicots	Line 2b. should read: Leaves simple and entire, toothed, or lobed (even cleft deeply), but not dissected —15

70	Dicots	Line 8b. should read: Leaflets (or leaves) coarsely toothed or lobed—12
71	Dicots	Line 14b. should read: Petals pink or blue (rarely white in albino flowers); stamens 5; ovary 1—14.5
71	Dicots	Add new couplet between 14 and 15: 14.5a. Petals pink; leaves pinnately dissected—***Erodium cicutarium***, in GERANIACEAE, p. 217 14.5b. Petals blue (rarely white in albino flowers); leaves deeply cleft, nearly dissected—***Viola*** spp., in VIOLACEAE, p. 236
77	Dicots	Line 81b should lead to new couplet 87.5.
78	Dicots	Add new couplet between 87 and 88: 87.5a. Sepals greenish or white, petals absent—***Mollugo verticillata***, in MOLLUGINACEAE, p. 156 87.5b. Sepals usually green, petals present—88
85	Dicots	Line 172a. should read "calyx of 5 sepals, the outer 2 much narrower than the *inner* 3"
191	Rosaceae	Line 3b. should read "each flower 10 mm or more wide"
192	Rosaceae	Changes to couplet 8: 8a. Leaves pinnately compound (or if trifoliolate, then flowers pink); flowers pink or red, rarely white or yellow, 2–10 cm across; fruit of achenes enclosed in a fleshy receptacle (early summer) (***Rosa*** spp., **Rose**)—9 8b. Leaves trifoliolate or palmately compound; flowers white, 1–3 cm across; fruit a cluster of fleshy drupelets (late spring) (***Rubus*** spp. in part, **Bramble**)—19
240	Elaeagnaceae	Family description should read "Shrubs or small trees with opposite or alternate, simple, entire leaves covered with silvery and/or rusty scales."
272	Boraginaceae	Changes to couplet 3: 3a. Corolla tubular, 10mm long or more, the lobes erect, the tube distinctly longer than the calyx—4 3b. Corolla funnelform or salverform, mostly less than 10 mm long, the lobes spreading, the tube equaling, shorter than, or occasionally longer than the calyx—7
283	Labiatae	Changes to couplet 39: 39a. All flowers in terminal panicles; corolla two-lipped; occasional escape from cultivation (40-80 cm high; summer)—**Oregano**, ***Origanum vulgare*** 39b. All flowers in axillary whorls, corolla almost regular or two-lipped—39.5
283	Labiatae	Add new couplet between 39 and 40: 39.5a. Corolla almost regular; moist areas (20-80 cm high) —**Wild Mint**, ***Mentha arvensis*** 39.5b. Corolla two-lipped; fields, roadsides, railroad rights-of-

		way, etc. (30–100 cm high, summer and autumn)—**Catnip**, ***Nepeta cataria***
290	Scrophulariaceae	Line 16a. should lead to new couplet 16.5.
290	Scrophulariaceae	Add new couplet between 16 and 17: 16.5a. Corolla with a spur which protrudes between the lower two lobes of the calyx; railroad ballast, roadsides, etc.; 10–50 cm high—**Dwarf Snapdragon**, ***Chaenorrhinum minus*** 16.5 b. Corolla lacks a spur—17
290	Scrophulariaceae	Line 20b. should read: Filaments four, all fertile; corolla two-lipped *or not*—26
347	Glossary	**Dissected**: Leaf blade, usually of a pinnate leaf, which is extremely finely divided (*Fig. 8*)
349	Glossary	Insert new term: **Lacinate**: cut into narrow segments
352	Glossary	Insert new term: **Scarious**: thin, of dry texture, not green
397	Index	Add Virginia Creeper, p. 231 after Violet

SUGGESTIONS FOR CONTRIBUTORS

1. Create text in 12-point Times-Roman. Please do *not* introduce font changes within the body of the text. Tab at beginning of paragraphs. Please do not use "First line indent," or any other such feature on your word-processing software. Include your e-mail address as a separate line, and telephone number(s) as well if you care to.

2. Create tables as typist's tables; i.e., with tabs. If you use the "Tables" software feature, then convert it to a tab-delimited format before submitting it. Each table is to be submitted as a separate file.

3. Spreadsheets are unacceptable; the typesetter cannot manipulate them. Convert them to tab-delimited tables.

4. Send each figure as a separate file, in a high-resolution format—jpg or tif. The typesetter cannot deal with Power-Point files. Figures like bar graphs that gain their meaning with color won't work—use coarse-grained cross-hatching, etc. Do not include the legend for the figure within the figure. Create figure legends as a separate text file, and the typesetter will insert them as appropriate.

5. Do not assemble the paper. The typesetter will insert your figures and tables as near to their first reference as possible.

6. Eschew abbreviations, particularly in "Literature Cited." Separate author's initials with a space; put a space after the colon when you're citing volume number: and page numbers.

7. Entries in "Literature Cited" are to be typed as hanging indents—simple in WordPerfect, more complex but doable in Word.

8. Italicize scientific names—no underlining.

9. Shorter papers may be submitted as e-mail attachments. You may mail CDs, standard 3.5" diskettes, and Zip diskettes up to 750 megabytes.

10. The editor appreciates "Suggested Reviewers," with e-mail addresses.

CONTENTS

On the cover: *Scott Falls [sometimes, Scott's Falls] on the south side of M-28, across from H. J. Rathfoot State Roadside Park, eleven miles west of Munising, in Michigan's Upper Peninsula, Alger County. This is the famous bryophyte site featured in the Michigan Botanist article by Peet, Crum, & Glime, 42(2): 103–104. 2003. Photo by Caryle Spence, early October 2003.*

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Articles dealing with any phase of botany relating to the Great Lakes Region may be sent to the Editor at the address above. In preparing manuscripts, authors are requested to follow our style as well as "Suggestions for contributors" on Cover 3.

THE MICHIGAN BOTANICAL CLUB

Membership is open to anyone interested in its aims: conservation of all native plants; education of the public to appreciate and preserve plant life; sponsorship of research and publication on the plant life of the State and the Great Lakes area in general, both in the USA and in Canada; sponsorship of legislation to promote the preservation of Michigan's native flora; establishment of suitable sanctuaries and natural areas, and cooperation in programs concerned with the wise use and conservation of all natural resources and scenic features.

Dues are modest, but vary slightly among the chapters. "Chapters members" should contact the chapter presidents listed below. "Special Members" (not affiliated with a chapter) may send US$21 to Irene Eiseman, MBC Special Membership Chairperson, 1873 Pierce Road, Chelsea, MI 48118, 734. 475. 9654. For both classes of membership, annual dues include a subscription to The Michigan Botanist. Address changes for Chapter Members should go to the Chapter President; address changes for Special Members should go to Irene Eiseman.

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A GUIDE TO REFERENCES FOR CURATORS OF SMALL HERBARIA

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From time to time those of us who manage herbaria will get a letter or a telephone call from a former student or person working for a company or agency needing information on topics like making a collection of plant voucher specimens, or setting up a herbarium. Perhaps you are a teacher who has arrived at an institution and found bundles of student collections from previous years, and you want to set up a teaching herbarium to go along with courses being taught. Or perhaps, you work for an environmental consulting firm and need vouchers for comparison work. So, how does one go about setting up an herbarium for student and/or local use? "What references are most helpful sitting on the shelf for identification and curation of plant specimens?"

We have compiled information that we feel would be helpful to an individual beginning a curatorial adventure centered in upper Mid-West North America, with emphasis on the Great Lakes region. The list of floras provided reflects this geographic area. Most information has been gleaned through experience and from some key references given below. Two books especially helpful were: Frodin, D. G. 2001. Guide to Standard Floras of the World, 2nd ed. Cambridge University Press, Cambridge, 1100 pp., and Woodland, D. W. 2000. Contemporary Plant Systematics, 3rd ed. Andrews University Press, Berrien Springs, MI, 569 pp. The references we feel are a "must have" are indicated by an asterisk *. Comments explaining the use or value of a reference are given following many bibliographic entries.

Herbarium Techniques

*Bridson, D. & L. Forman (eds.). 1998. The Herbarium Handbook, 3rd ed. Royal Botanic Gardens, Kew, UK, 334 pp. This book is filled with all types of information from two senior British botanists.

Croat, T. B. 1978. Survey of herbarium problems. Taxon 27: 203–218.

Edwards, S. R., et al. (eds.). 1981. Pest Control in Museums: A Status Report. Association of Systematics Collections, Lawrence, KA.

MacFarlane, R. B. A. 1985. Collecting and Preserving Plants for Science and Pleasure. Arco Publishing, New York, 184 pp.

*Metsger, D. A. & S. C. Byers (eds.). 1999. Managing the Modern Herbarium. Society for the Preservation of Natural History Collections, Washington, DC. 384 pp. This is a must read for any person thinking of doing curatorial work.

Radford, A. E., et al. 1974. Vascular Plant Systematics. Harper & Row, New York, 891 pp. This is a resource book, not a text.

Zycherman, L. A. & J. R. Schrock (eds.). 1988. A Guide to Museum Pest Control. Association of Systematic Collections, Washington, DC, 205 pp.

Indexes for Bibliographic, Illustrative, and Nomenclatural Literature

*Brummitt, R. K. 1992. Vascular Plant Families and Genera. Royal Botanic Gardens, Kew, UK, 804 pp. This volume lists nearly 14,000 accepted generic names, and over 10,000 other names, with their authors as currently used at the Royal Botanic Gardens, Kew, UK. The accepted names are also listed family by family for easy reference.

Greuter, W. et al. (eds.). 2000. International Code of Botanical Nomenclature (Saint Louis Code). Regnum Vegetabile Vol. 138. Koeltz Scientific Books, Koningstein, Germany. 474 pp. This is the most recent code of rules that govern naming in botany as adopted by the Sixteenth International Botanical Congress in St. Louis, Missouri, in 1999. A more recent revision will be forthcoming based on the most recent congress during July 2005 in Vienna, Austria.

Hyam, R. & R. Pankhurst. 1995. Plants and Their Names. A Concise Dictionary. Oxford University Press, Oxford, 545 pp. This work provides a complete reference source to over 16,000 of the more commonly occurring vernacular and Latin names of plants.

*Mabberley, D. J. 1997. The Plant-Book. A Portable Dictionary of the Higher Plants, second edition. Cambridge University Press. Cambridge, UK. This work is an alphabetical listing of families and genera of vascular plants. It follows the Cronquist system of classification and has a layout much like Willis' A Dictionary of Flowering Plants. It includes information on family descriptions, distributions, number of species, economic uses, and examples, as well as less detailed information on synonymy and tribal and subfamily levels. Pertinent recent literature is also included. This is a very handy reference.

Terminology and Dictionaries

*Featherly, H. I. 1954. Taxonomic Terminology of the Higher Plants. Iowa State University Press, Ames (Reprinted 1965. Hafner, New York), 166 pp. A great find on the used book market.

Harrington, H. D. & L. W. Durrell. 1985. How to Identify Plants. Swallow Press, Athens, OH, 207 pp. An inexpensive paperback.

*Harris, J. G. & M. W. Harris. 1994. Plant Identification Terminology, and Illustration Glossary. Spring Lake Publishing, Payson, Utah, 198 pp.

*Jackson, B. D. 1928. A Glossary of Botanic Terms, with the Derivation and Accent. Duckworth, London (Reprinted 1960. Hafner, New York), 481 pp. A great old reference dictionary that has many of the older botanical descriptive names. It is worth looking in used book outlets for a good copy.

Redford, A. E., et al. 1974. Vascular Plant Systematics. Harper & Row, New York, 891 pp.

*Stearn, W. T. 1992. Botanical Latin, 4th ed. David & Charles, London, 546 pp.

and Timber Press, Portland, Oregon, 2004, paperback. Still the classic when a wee bit of Latin is needed.

Specific and Comprehensive Guides

Brummitt, R. K. & C. E. Powell (eds.). 1992. Authors of Plant Names. Royal Botanic Gardens, Kew, UK, 732 pp. This book lists nearly 30,000 authors of plant Latin names and gives a recommended standardized abbreviation for each of these authors' names. Some biographic information is also given.

*Cronquist, A. 1981. An Integrated System of Classification of Flowering Plants. Columbia University Press, New York, 1262 pp. This is a most comprehensive study of flowering plant families, with detailed descriptions, examples, illustrations, keys to the families, and fossil record information, all of which are based around Cronquist's classification scheme, a scheme that has been largely replaced by a more recent one by the Angiosperm Phylogeny Group. This classification system can be accessed on the website of the Missouri Botanical Garden: <http://www.mobot.org/> and continue on to: <http://www.mobot.org/MOBOT/Research/APweb/welcome.html>.

*Holmgren, P. K. et al. 1991. Index Herbariorum. Part I. The Herbaria of the World. 8th ed. New York Botanic Gardens, Bronx, New York, 693 pp. This is the most valuable guide to the world's herbaria arranged by cities and with pertinent general information about each herbarium, including a standard acronym. It is now accessed via the website of the New York Botanic garden at: <http://www.nybg.org/>, and continue on to: <http://sciweb.nybg.org/science2/IndexHerbariorum.asp>.

Lawrence, G. H. M., et al. (eds.) 1968. B-P-H. Botanico-Periodicum-Huntianum. Hunt Botanical Library. Pittsburgh, PA (Supplementum 1991, written by G. D. R. Bridson & E. R. Smith.). This reference provides standardized abbreviations to over 20,000 botanical journals and is especially helpful in identifying older reference citations. This guide is used by many current botanical journals as a guide for abbreviating journal literature citations.

Basic Systematic texts

Benson, L. 1979. Plant Classification, 2nd ed. D. C. Heath, Lexington, MA, 901 pp.

*Heywood, V. H. (ed.). 1993. Flowering Plants of the World. B. T. Batford, London, 335 pp. It is said that a new edition of this lovely book is being prepared with family descriptions matching the new APG classification system. We hope the families will still have the lovely watercolor illustrations of the older edition.

*Judd, W. S., et al. 2002. Plant Systematics. A Phylogenetic Approach, 2nd ed. Sinauer Assoc., Inc., Sunderland, MA, 576 pp. This book has a color image CD to over 2,200 plant images. Classifies families according to the latest APG classification.

Porter, C. L. 1967. Taxonomy of Flowering Plants, 2nd ed. W. H. Freeman, San Francisco, 472 pp.

Stuessy, T. F. 1990. Plant Taxonomy. Columbia Univ. Press, New York, 514 pp.

*Woodland, D. W. 2000. Contemporary Plant Systematics, 3rd ed. Andrews Uni-

versity Press, Berrien Springs, MI, 569 pp. This text has the broadest geographical coverage of the books listed here. It gives a more global view and discusses the greatest number of vascular plant families. It includes a CD with more than 4,700 color images.

*Zomlefer, W. B. 1994. Guide to Flowering Plant Families. University of North Carolina Press, 430 pp. The textbook with the best and most varied sketches of family characters.

Floras and Manuals

A **flora** is a taxonomic treatment of all plants occurring in a geographical area. It can also refer to the plants living in a region. This area can be small, such as a nature preserve of a few hectares (or acres), or more extensive such as a regional, state, or country flora. Each written flora is developed following predetermined guidelines on the type of coverage to be included. These guidelines might involve all plants or only vascular plants; only a listing of names; descriptions, keys, and distributions; ecological, geological, or soil information; how the flora will be used; etc. The book with all or part of this information is called a **manual**; in practice, the two words are used interchangeably.

Bibliographies

Frodin, D. G. 2001. Guide to Standard Floras of the World, 2nd ed. Cambridge University Press, Cambridge, 1100 pp. This is a very expensive reference book and costs almost $300.00 and is normally out of reach of most herbaria. It may be purchased by some libraries and be available in the reference section of an academic library. It is the most extensive reference on this subject worldwide and makes it handy to know what books are available before a person travels to a foreign country. An abridged list is found in Appendix II of: Woodland, D. W. 2000. Contemporary Plant Systematics, 3rd ed. Andrews University Press, Berrien Springs, MI, 569 pp.

Cultivated Plant Manuals

*Bailey, L. H. 1949. Manual of Cultivated Plants, Revised ed. Macmillan Publ. Co., 1116 pp. Out of print. This is still the only manual to general cultivated plant species.

*Brickell, C. & H. M. Cathey (eds.). 2004. The American Horticultural Society A – Z Encyclopedia of Garden Plants, 2nd ed. DK Publishing, Inc., NY, 1099 pp. Here is the American edition of a Royal Horticultural Society publication. It is still the definitive recent guide to cultivated plants with 6,000 colored photographs and over 15,000 cultivated plants arranged alphabetically by Latin name.

*Rehder, A. 1986. Manual of Cultivated Trees and Shrubs Hardy in North America. (Reprint of 2nd ed. of 1940) Dioscorides Press, Portland, OR, 996 pp.

General Keys

The two references listed here are most helpful when you have plant material where the family is not recognized, when the specimen is a cultivated plant, or the origin is unknown.

*Cullen, J. 1997. The Identification of Flowering Plant Families: Including a Key to Those Native and Cultivated in North Temperate Regions, 4th ed. Cambridge University Press, Cambridge, 192 pp.

Hutchinson, J. 1967. Key to the Families of Flowering Plants of the World. Oxford University Press, Oxford, 117 pp.

Regional Floras that Include the Greats Lakes Region

Chadde, S. W. 2002. A Great Lakes Wetland Flora, 2nd. ed. Pocketflora Press, Calumet, MI, 648 pp.

*Crow, G. E. & C. B. Hellquist. 2000. Aquatic and Wetland Plants of Northeastern North America. 2 vols. University of Wisconsin Press, Madison, 600+ pp (revision of: Fassett, N. C. 1957. A Manual of Aquatic Plants. University Wisconsin Press, Madison, 405 pp.) The sketches are very large and very well done. Expensive.

*Elias, T. S. 1987. The Complete Trees of America. Gramercy Publishing, New York, 948 pp.

Fernald, M. L. 1950. Gray's Manual of Botany. 8th ed. American Book Co., New York, 1632 pp.

*Flora North America Editorial Committee. 1993—. Flora of North America. Vol. 1—. Oxford University Press, New York (a new, multi-volume series). This will ultimately be a 30 volume series to the over 20,000 species of vascular plants in North America. Approximately one-fourth of the volumes have been published with other volumes in various stages of preparation. Every herbarium curator should have access to a set if at all possible.

*Gleason, H. A. & A. C. Cronquist. 1991. Manual of the Vascular Plants of the Northeastern United States and Adjacent Canada. The New York Botanical Garden, Bronx, 7th printing [2004], xlvi + 993 pp.

Hosie, R. C. 1979. Native Trees of Canada, 8th ed. Fitzhenry & Whiteside, Don Mills, Ontario, 380 pp.

Isely, D. 1960. Weed Identification and Control, 2nd ed. Iowa State University Press, Ames, 400 pp.

Ladd, D. 1995. Tallgrass Prairie Wild Flowers. Falcon Publishing Co., 264 pp.

*Lellinger, D. B. 1985. A Manual of the Ferns & Fern Allies of the United States. Smithsonian Institution Press, Washington, DC, 446 pp.

Looman, J. & K. F. Best. 1987. Budd's Flora of the Canadian Prairie Provinces. Research Branch, Agriculture Canada, No. 1662. Canadian Government Publishing Centre, Hull, Québec, 863 pp.

Mickel, J. 1979. How to Know the Ferns and Fern Allies. W. C. Brown, Dubuque, Iowa, 229 pp.

*Newcomb, L. 1989. Newcomb's Wildflower Guide: An Ingenious New Key System for Quick, Positive Field Identification of the Wildflowers, Flowering Shrubs and Vines of North America. (Reprint ed.), Little Brown & Co., 490 pp.

Peterson, R. T. & M. McKenny. 1998. Field Guide to Wild Flowers of Northeastern and North Central North America, revised ed. Houghton-Mifflin, Boston, 420 pp.

*Pohl, R. W. 1968. How to Know the Grasses, 2nd ed. W. C. Brown, Dubuque, Iowa, 244 pp.
*Preston, R. J. 1989. North American Trees, 4th ed. Iowa State Univ. Press, Ames, 407 pp.
Rehder, A. 1986. Manual of Cultivated Trees and Shrubs Hardy in North America. (Reprint of 2nd ed. of 1940) Dioscorides Press, Portland, Oregon, 996 pp.
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DISTRIBUTION OF ECOLOGICALLY-INVASIVE PLANTS ALONG OFF-ROAD VEHICLE TRAILS IN THE CHEQUAMEGON NATIONAL FOREST, WISCONSIN

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ABSTRACT

To describe the invasive flora of off-road vehicle (ORV) trails, I combined field surveys for 7 invasive plant species along 2 ORV trails and seed surveys via soil samples taken from the undercarriage of ORVs. Field surveys identified 4 of the 7 species (*Centaurea biebersteinii*, *Phalaris arundinacea*, *Hieracium aurantiacum*, and *Lotus corniculata*), and at least one invasive plant occurred along 88% of the 100 m trail segments surveyed. *Alliaria petiolata Euphorbia esula,* and *Lythrum salicaria* were not present, but are included in the analysis for comparative purposes. Some ORVs dispersed seeds. While none of the seeds were invasive species, they were the same size as the invasive plants in this study. Because many invasive species have seed traits that predispose them for vehicular dispersal, ORVs occasionally contribute to long-distance dispersal events.

INTRODUCTION

Reducing the threat of invasive species requires that we identify and understand the ways humans facilitate their transport to and establishment in new areas (Floerl and Inglis 2005). Roads are known to harbor disproportionately more invasive plant species than surrounding habitats (Trombulak and Frissell. 2000; Watkins et al. 2003; Hansen and Clevenger 2005). Roadsides act as demographic source populations for some invasive plants, enabling them to disperse into habitats perpendicular to the road (Tyser and Worley 1992; Hansen and Clevenger 2005). Less studied are similar edge effects associated with other transportation corridors, including utility and railroad rights-of-way, and hiking, biking, and off-road vehicle (ORV) trails. Knowledge of the invasive flora along trails is important because recurring traffic provides a vector for long-distance dispersal.

Wisconsin has 35 public trail systems and connectors designed for ORV use (which include both motorcycles and 4-wheel all-terrain vehicles designed specifically for off-road use). These trails stretch over 2700 km. In this study, I recorded the frequency of 7 invasive species (Table 1) along trail segments in northern Wisconsin. I also indirectly evaluated the potential for ORVs as seed dispersal agents for these invasive species. My goal was to develop a better understanding the role of ORVs and ORV trails in facilitating the spread of invasive plants.

TABLE 1. Ecologically-invasive plants species included in this study. Seed mass is based on the mean weight of 10–20 seeds taken from herbarium specimens at the University of Wisconsin Herbarium in Madison.

Common Name	Scientific Name	Seed Mass (in mg)	Dispersal Mode
garlic mustard	*Alliaria petiolata* (M. Bieb.) Cavara & Grande (Brassicaceae)	1.8	gravity
spotted knapweed	*Centaurea biebersteinii* DC. (Asteraceae)	2.4	wind
purple loosestrife	*Lythrum salicaria* L. (Lythraceae)	4.0	gravity, water
leafy spurge	*Euphorbia esula* L. var. *esula* (Euphorbiaceae)	2.8	gravity, wind, animal
reed canary grass	*Phalaris arundinacea* L. (Poaceae)	0.4	gravity, water
orange hawkweed	*Hieracium aurantiacum* L. (Asteraceae)	0.2	wind
birds-foot trefoil	*Lotus corniculata* L. (Fabaceae)	1.1	gravity

METHODS

I conducted invasive plant field surveys along ORV trails in Price, Sawyer, and Ashland Counties in northern Wisconsin (46°N, 90.5°W), in the Chequamegon National Forest. The northern Wisconsin landscape contains a mixture of public lands, private-industrial and non-industrial forests, lakes, wetlands, and small towns. These particular trails are situated within the Chippewa Lobe Rocky Ground Moraine and the Chequmegon Morain and Outwash Plain subregions nested within the Northern Lakes and Forests ecoregion (Omernik et al. 2000). Forest is the dominant landcover in the region, covering approximately 70% of the area (MacKenzie 1994).

I surveyed for 7 non-native species (Table 1) classified as "ecologically invasive" by Wetter et al. (2001). These species invade wild areas in Wisconsin, outcompete native species, alter or degrade habitats, and cause extensive ecological damage (Hoffman and Kearns 1997, Czarapata 2005). Six are well-established in northern Wisconsin; only garlic mustard is not yet widespread. Nomenclature follows Wetter et al. (2001).

In August 2002, I conducted trail surveys along portions of the 90.1 km Dead Horse Run Trail and the 96.5 km Flambeau Trail. These unpaved trails are approximately 3 m wide, traversing mature and regenerating forest, shallow marshes, bogs, conifer swamps, and lakeshores. I divided trails into 100 m survey segments, and walked transects from a trailhead for a set distance (either 1000 m or 2000 m), recording the presence or absence of invasive species in each segment. I then traveled to another trailhead and repeated the procedure. Two segments were surveyed per trail (n = 30 segments per trail, 2 trails sampled, 6 km surveyed).

Because small seeds can be dispersed via soil adhesion to vehicles (Ridley 1930, Hodkinson and Thompson 1997), I collected soil from ORVs as riders exited the Dead Horse Run trail in August 2002. Of 14 vehicles sampled on a single day, only 6 had soil encrusted on the frame and undercarriage. I collected some of the soil (approximately 50–200 g) using a metal spatula, and placed the soil in a plastic bag. A separate bag was used for each vehicle. Rather than sieve soils for seeds, I elected to mix them with Jiffy Mix; I placed them in a flat, and stored them for 165 days at 5°C. Flats were periodically watered, and were subsequently moved to a growth chamber simulating a long day environment (16 hours of light, 8 hours of dark), and temperatures fluctuated between 6°C during simulated night to 30°C during simulated day. Flats were watered and monitored daily for seedling ger-

mination and for 140 days following the first day of germination. I recorded the number of flats with seeds germinating, and the number of germinating seeds per flat.

RESULTS

Four invasive species were encountered along at least one trail, with an average of 1.1 species per 100 m segment (Table 2). Invasive species were present in 88.3% of the sixty 100 m trail segments surveyed: 83.3% of the Dead Horse Trail segments and 93.3% of the Flambeau Trail segments had invasive species.

Some but not all ORVs transport seeds in soil adhering to the vehicle. Four of the 6 soil samples collected from ORVs germinated seeds, with 41 individual plants germinating. Of the 14 vehicles sampled for seeds, there were a mean 3.6 viable seeds per vehicle sample. All except two of the plants germinating were the native common oak sedge (*Carex pensylvanica* Lam.). Based on measurements from herbarium specimens, this species has an average seed mass of 3.0 mg/seed (n = 10), which is similar to the seed mass of the invasive species listed in Table 1.

DISCUSSION

Orange hawkweed and birds-foot trefoil were the most abundant species found along both trails surveyed (Table 2). Both are frequently found along roadsides in this region, and ORV trails provide suitable habitat. Orange hawkweed tolerates a broad range of ecological conditions. While it reaches its greatest abundance along roadsides, it is often found tens of meters beyond the forest edge (Wiegmann and Waller in press). Its impacts on native plant species are unknown. Because orange hawkweed is wind dispersed, ORVs most likely play only an incidental role in its dispersal. The nitrogen-fixing birds-foot trefoil is less shade tolerant than orange hawkweed, making it less likely to invade forest interiors. As with orange hawkweed, ORV trails provide suitable habitat. Infrequent dispersal of birds-foot treefoil by ORVs seems likely, as populations were encountered within 200 m of road crossings. Because this species is still pro-

TABLE 2. Percentage of 100 m segments of ORV trail occupied by invasive species in Table 1. N = 30 segments for each trail surveyed

Invasive species Common Name	ORV Trail Name	
	Dead Horse Run	Flambeau
garlic mustard	0%	0%
spotted knapweed	3%	3%
purple loosestrife	0%	0%
leafy spurge	0%	0%
reed canary grass	0%	10%
orange hawkweed	83%	93%
birds-foot trefoil	17%	10%

moted as a forage crop and is added to wildlife seed mixes, deliberate planting remains the most important dispersal vector for this species.

Reed canary grass and spotted knapweed were present, but both were still relatively uncommon. Both species are highly invasive (Barnes 1999; DiTomaso 2000), but are also less likely to invade upland forest interiors. Reed canary grass was found only along the shores of wetlands and lakeshores, and spotted knapweed was restricted to open habitats. Spotted knapweed benefits from the existence of ORV trails, but reed canary grass probably benefits little. Because both species are wind dispersed, ORVs probably do not account for ecologically-significant seed dispersal.

Garlic mustard, purple loosestrife, and leafy spurge were not observed in this study. Of these, garlic mustard is most likely to use ORV trails as an invasion pathway. This small-seeded, gravity-dispersed plant inhabits open and disturbed areas, forest edge, and forest interiors (Meekins and McCarthy 2001). In this region, I most often observed this species along the sides of frequently-driven roads, often near resort areas. I expect purple loosestrife and leafy spurge to exhibit many of the same invasion patterns as reed canary grass and spotted knapweed, respectively. Off-road vehicles will not account for ecologically-significant seed dispersal, but the trail infrastructure will provide suitable habitat for both.

Plant species most likely to be transported by motor vehicles are those with small seeds that are gravity or wind-dispersed, have high seed production, and form persistent seed banks (Schmidt 1989, Hodkinson and Thompson 1997). All 7 invasive species have these traits. In fact, these traits are characteristic of invasive plants generally (Rejmánek and Richardson 1996). Vehicular dispersal of seeds is not random; invasive species are better adapted to vehicular dispersal than noninvasive species.

Environmental assessment of ORVs is often limited to studies of soil compaction, erosion, and vegetation damage. The impacts associated with invasive species receive little attention. While vegetation and soil damage can be often be reversed after several years, invasive plants are difficult to eradicate once established. Also, while ORV damage to soils and vegetation is often localized, invasive species often spread beyond points of colonization. Thus, the spread of invasive plant species deserves attention as a potential environmental impact associated with ORVs. Botanists would do well to remind land managers that this is an unavoidable tradeoff of maintaining trails.

ACKNOWLEDGMENTS

Hugh Iltis was kind enough to permit me to remove seeds from mounted specimens at the University of Wisconsin Herbarium. Kelly Kearns, Brian McCarthy, and Dave Rogers provided helpful comments on earlier versions of this study. The Natural Trails and Waters Coalition provided financial support through the Superior Wilderness Action Network.

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THE BIG TREES AND SHRUBS OF MICHIGAN
48. *Quercus velutina* Lam.
Black Oak

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The largest known Black Oak in Michigan is located in Algonac in St. Clair County in the southeastern portion of Michigan's Lower Peninsula.

Description of the species: Black Oaks belong to the Red Oak group (subgenus *Erythrobalanus*). They therefore have leaves that are thick and leathery with bristle-tipped lobes. The sinuses between the lobes are generally shallow and broad but extend halfway or more to the midrib (Fig. 1). The winter buds are sharply angled and tomentose. The acorns are sessile or short stalked with deep bowl-shaped cups which cover 1/3 to 1/2 of the nut. The scales of the cup are thin and loose fitting, forming a slight fringe. The inner bark of this species is thick, bitter tasting, and bright yellow or orange. This is a highly variable species which is known to form hybrids with Red Oak, Scarlet Oak, and Shingle Oak (Voss, 1985).

Location of Michigan's Big Tree: The State Champion Black Oak is located in the courtyard of an elementary school at Washington and Clay Streets in Algonac, MI. To reach the tree, take State Route 29 south from Port Huron past Marine City and Algonac State Park. Turn right on Smith Street and go two blocks to the school. The coordinates for this location are 42° 37.240′ N, 82° 31.923′ W.

Description of Michigan's Big Tree: The tree has a single, solid, healthy trunk with several large burls. Several branches exhibit tip dieback. According to the school principal, Mr. Terry Wallis, several large branches had to be cut back when they threatened the school roof. It is a testament to the pride the area takes in this tree that they built the school around it! I measured the girth of the trunk at 256″ on 3 September 2003. The height was 120′ and the average crown spread 80′. The total points for this tree (G+H+ 1/4 × crown spread) is, therefore, 256 + 120 + 1/4 × 80 = 396.

INVITATION TO PARTICIPATE

If you would like to join in extending this series of articles by visiting and describing one or more of Michigan's Big Trees, please contact Elwood B. Ehrle, woodyehrle5098@sbcglobal.net, for help with locations, specifications for taking measurements, and assistance with the manuscript. The Michigan Botanical

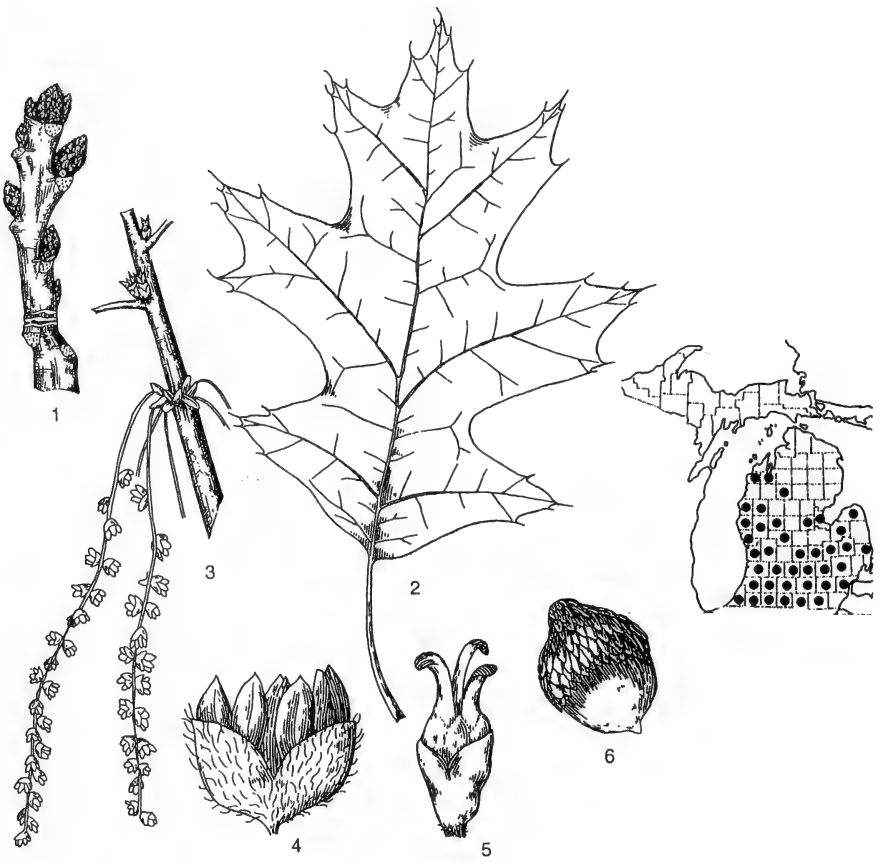

FIGURE 1. Documented distribution and characteristics of the Black Oak. The map is from Voss 1985. The illustration is from Barnes and Wagner 1981. 1. Winter twig, ×1. 2. Leaf, ×1/2. 3. Flowering shoot, × 1/2. 4. Male flower, enlarged. 5. Female flower, enlarged. 6. Fruit, acorn, ×1.

Club encourages your involvement with this activity. Please remember to ask permission before entering private property.

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THE BIG TREES AND SHRUBS OF MICHIGAN
49. Ailanthus altissima (Miller) Swingle
Tree-of-Heaven

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The largest known Tree-of-Heaven in Michigan is located in Maryville, MI in St. Clair County in the southeastern portion of Michigan's Lower Peninsula.

Description of the Species: The Tree-of-Heaven can be easily recognized by its very large pinnately compound leaves (See Fig. 1), which can be up to three feet long. The leaflets have two or more coarse teeth at their base which are gland-tipped on the underside. Even without leaves, the tree can be easily recognized by its large leaf scars, each of which has nine or more bundle scars arranged in a U-shaped pattern.

The Tree-of-Heaven is frequently seen in urban settings. It often grows against buildings and in vacant lots. This tree was celebrated by Betty Smith in her novel, *A Tree Grows in Brooklyn.* (Elias, 1980). It is a native of China and was introduced to Europe and North America in 1784 (Voss, 1985) as a food plant for silk worms.

Location and Description of Michigan's Big Tree: The State Champion Tree-of-Heaven is located next to a yellow house at 4003 Electric Ave. near the corner of Sturges Rd. in Maryville, MI. There is another large Tree-of-Heaven on the other side of the house and there are many young seedlings under the tree. Its coordinates are 42° 56.291′ N × 82° 27.263′ W. To reach the tree, take Rt. 25 south from downtown Port Huron. It becomes Electric Ave. in Maryville. Follow Electric Ave. to Sturges St. and the tree is near the corner.

There is another large Tree-of-Heaven near the corner of Dexter and Phillips St. in Milan, MI, south of Ann Arbor in Washtenaw County, in the southeastern portion of Michigan's Lower Peninsula. This tree can be reached by taking Rt. 23 south from Ann Arbor to Carpenter St. (exit 27). Carpenter St. becomes Dexter St. in Milan, MI. Continue on Dexter St. to Phillips St. The tree is in the front yard of a white house at 745 Dexter St.

I measured the girth of the Maryville State Champion tree at 200″ on September 4, 2003. Its height was 63′ and its average crown spread 76′. The total points (G + H + 1/4 × C.S.) were therefore 200 + 63 + 1/4 × 76 = 282. The trunk has developed a crack with rot inside starting at three feet. The first branch is eight feet from the ground.

The Milan tree was measured by Gail McPherson of Global ReLeaf of Michigan, Richard Pomorski, noted Ann Arbor Big Tree hunter, and myself on August 23, 2003. The girth was measured at 180″ the height was 55′ and the average

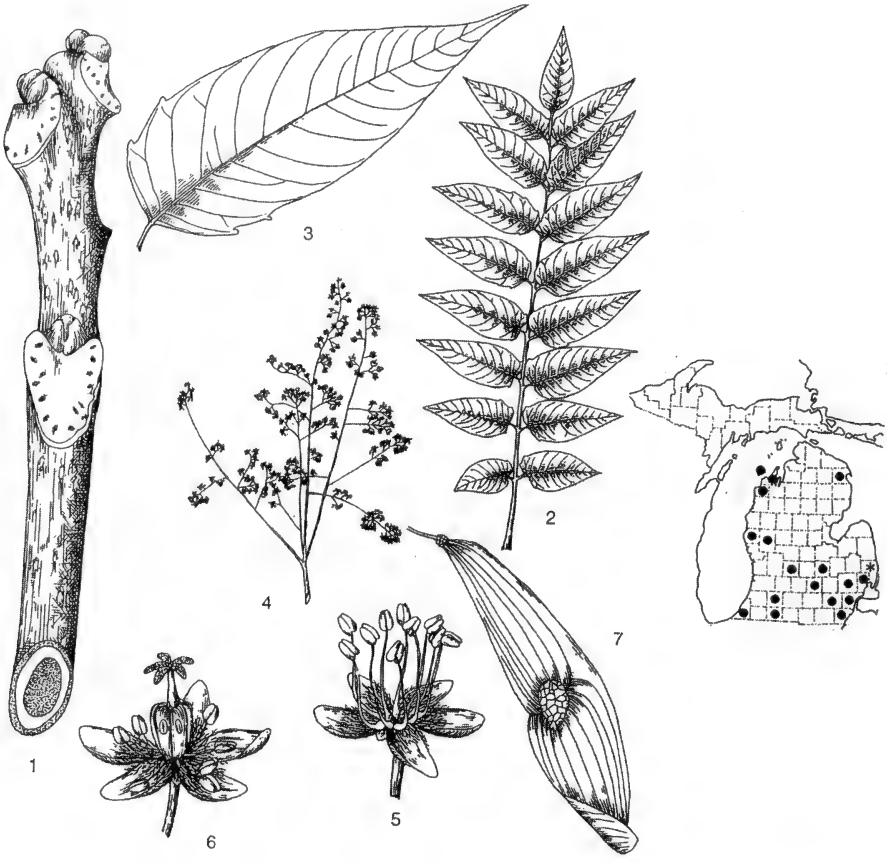

FIGURE 1. The documented distribution in Michigan and characteristics of the Tree-of-Heaven. The map is from Voss (1985). The asterisk indicates the location of Michigan's Champion tree. The illustration is from Barnes and Wagner (1981). 1. Winter twig, × 1. 2. Leaf, × 1/8. 3. Leaflet × 1/2. 4. Male inflorescence, × 1/4. 5. Male flower, enlarged. 6. Female flower, enlarged. 7. Fruit, samara, × 1.

crown spread 60′. The total points for the Milan tree were 180 + 55 + 1/4 × 60 = 250. The coordinates for the Milan tree are 42° 05.481′ N × 83° 40.605′ W.

INVITATION TO PARTICIPATE

If you would like to join in extending this series of articles by visiting and describing one or more of Michigan's Big Trees, please contact Elwood B. Ehrle (woodyehrle5098@sbcglobal.net) for help with locations, specifications for taking measurements, and assistance with the manuscript. The Michigan Botanical

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ADDITIONS TO THE LICHEN FLORA OF WISCONSIN WITH NEW RECORDS OF RARE SPECIES

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Two lichen species are reported as new to Wisconsin: *Physcia dakotensis* Essl. and *Physconia subpallida* Essl. New records of *Caloplaca saxicola* (Hoffm.) Nordin, *Cetraria arenaria* Kärnefelt, *Coccocarpia palmicola* (Sprengel) Arv. & D. J. Galloway and *Teloschistes chrysophthalmus* (L.) Th. Fr., all of which are rare or endangered at the state level, are reported. *Coccocarpia palmicola* is proposed for inclusion in the state's endangered species list, and changes in the conservation status of *Cetraria arenaria* and *Teloschistes chrysophthalmus* are suggested.

NEW RECORDS FOR WISCONSIN

Physcia dakotensis Essl. (Physciaceae)
WISCONSIN. Dane County: Southeast of Madison, 30 May 1949, *Thomson 4632* (WIS).

This represents the easternmost record of this newly described species (Esslinger 2004), and the first report of this species east of the Mississippi River. Its presence in Wisconsin is somewhat expected as it is known from Iowa and Minnesota. This taxon appears to be more of a prairie species, occurring on acidic rock in open, sunny locations across the northern Great Plains (Esslinger 2004).

Physconia subpallida Essl. (Physciaceae)
WISCONSIN. Sawyer County: Flambeau River State Forest, 23 August 1951, *J.W. Thomson & M.E. Hale, Jr. 4465* (WIS).

This species is new to Wisconsin, known only from Sawyer county; however, its range in the state may be much broader. *Physconia subpallida* is typically corticolous, occurring on hardwoods in eastern North America, and extending as far west as Iowa (Esslinger 1994).

ADDITIONAL RECORDS OF RARE TAXA

Caloplaca saxicola (Hoffm.) Nordin (Teloschistaceae)
WISCONSIN. Trempealeau County: Perrot State Park, 23 July 2005, *Nelsen 3984* (WIS).

Caloplaca saxicola appears to be a rare crust in Wisconsin (Thomson and Will-Wolf 2000), having only been reported twice in the state (Thomson 1998, 2003). Despite its rarity, it is not a taxon of special concern (Thomson and Will-Wolf 2000). *Caloplaca saxicola* appears to prefer open, sunny conditions and should be looked for on calcareous stone in prairies and on bluffs.

Cetraria arenaria Kärnefelt (Parmeliaceae)
WISCONSIN. Grant County: Lower Wisconsin River State Wildlife Area, 28 August 2004, *Nelsen 3981* (WIS).

This species is known from scattered localities around Wisconsin, however, two of the sites at which this species has been found (in Polk and Sauk counties) have been destroyed (Thomson 2003). *C. arenaria* has also been found along the Lake Michigan shore and in Grant and Iowa counties on sandy soils.

It is classified as rare in Wisconsin (Thomson and Will-Wolf 2000; Thomson 2003; Bennett and Wetmore 2004) and received a state rank of SH in Bennett and Wetmore (2004). This rank means that the species is historically known from the state, but has not been collected in the past 20 years, making its existence questionable and designating its need for re-verification. The collection reported here serves as a reminder that *C. arenaria* still exists in Wisconsin, and has not disappeared. Because of this, it is proposed that its state rank be changed from SH to imperiled (S2). The S2 rank is given to species that are imperiled in the state due to rarity (6–20 occurrences or few remaining individuals or acres) or because of factors believed to make the species vulnerable to extirptation (Wisconsin Natural Heritage Program 2004). Other sites in which this species has been found should be re-investigated to determine if this species is critically imperiled (rank S1: 5 or fewer occurrences in the state or certain factors make the species especially vulnerable to extirpation) in Wisconsin.

Coccocarpia palmicola (Sprengel) Arv. & D. J. Galloway (Coccocarpiaceae)
WISCONSIN. Iowa County: Ridgeway Township, on calcareous stone, 19 June 2004, *Nelsen 3982* (WIS).

This foliose cyanolichen is known in Wisconsin only from the St. Croix National Scenic Riverway (Wetmore and Bennett 2004). It occurs in Minnesota (Wetmore 2000) and Illinois (Arvidsson 1982), but has not been found in Michigan (Fryday et al. 2001). It is primarily a tropical genus (Arvidsson 1982), extending north in coastal areas. Its range extensions into Minnesota and Wisconsin are of great importance as they represent its northernmost limit in midwestern North America (Brodo 2001).

As only one previous record in Wisconsin exists, the rareness of this species is apparent. Several studies of saxicolous and corticolous lichens in southwest Wisconsin have not encountered this species (Armstrong 1968; Cole 1977; Culberson 1955; Foote 1963, 1966; Hale 1955; Makholm 2003; Will-Wolf 1980). It is considered threatened in Minnesota (Minnesota Department of Natural Resources 2004) and because of its rarity in the Great Lakes area, it is proposed that this taxon be included in Wisconsin's rare and endangered species list and receive a rank of S1 (described above).

Teloschistes chrysophthalmus (L.) Th. Fr. (Teloschistaceae)
WISCONSIN. Dane County: Festge Park, 11 December 1999, *Nelsen 683* (WIS).

This collection was made as part of a study in the Madison, WI area (Nelsen 2000). It appears to be the first collection of *T. chrysophthalmus* in Wisconsin since the late 1800s or early-mid 1900s. The only known collections were made in 1892 by L. Cheney, and in 1893 by Heald and Buell (Thomson 1998). A literature report from 1924 exists (Rentz and Lappley 1925); however, no specimen can be found in WIS for verification. Another specimen is currently known from a private residence in Waukesha county, but has not been collected due to its rarity. This individual was first noticed when it was a juvenile, and has been monitored for the past 3 years.

This species appears to be declining throughout many parts of North America (Wilhelm 1998; Flenniken 1999; Brodo et al. 2001; Fryday et al. 2001; Showman and Flenniken 2004). Its disappearance is most likely the result of habitat destruction and increased air pollution (Brodo et al. 2001). It is proposed that the conservation rank of this species in Wisconsin be changed from SH to critically imperiled (S1), based on its extreme rarity. Fryday and Wetmore (2002) considered *T. chrysophthalmus* to be critically endangered in Michigan, while in Minnesota, this species is not yet considered rare (Minnesota Department of Natural Resources 2004). The Waukesha county individual will continue to be monitored and it is hoped that air pollution from a recently constructed highway will not poison it.

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THE BASIDIOLICHEN *MULTICLAVULA MUCIDA* (FR.) PETERSEN: NEW TO MICHIGAN

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While most lichen-forming fungi belong to the Ascomycota, a small number are known among the Basidiomycota (Oberwinkler 2001). Of the three basidiomycete lichen genera known in North America (Esslinger 1997) only *Multiclavula* and *Lichenomphalia* (*Omphalina*) occur in temperate to boreal regions (Brodo et al. 2001). These two genera produce ephemeral fruiting bodies, which make them difficult to detect when basidiocarps are not present. *Multiclavula* does not form a specialized, unique thallus as the result of lichenization; because of this, its classification as a lichen is arguable (Brodo et al. 2001). However, it is included as a lichen in the North American Lichen Checklist (Esslinger 1997) and is discussed as one here. While many *Multiclavula* species are tropical in nature, five are known from North America (Esslinger 1997; Brodo et al. 2001), and the first is reported for the state of Michigan.

NEW RECORD FOR MICHIGAN

Multiclavula mucida (Fr.) Petersen (Clavariaceae)
MICHIGAN. Baraga County: Found on a rotting log in the King's Lake Campground area, 17 September 2005, *Nelsen 3980* (MSC).

This appears to be the most cosmopolitan of the *Multiclavula* species (Petersen 1967) and is known from southern Ontario (Wong & Brodo 1992), Wisconsin (Wetmore & Bennett 2002; Thomson 2003; Lay 2004), and throughout eastern North America (Brodo et al. 2001). It typically occurs on an algal mat (thought to be *Coccomyxa*) on shaded, rotten logs and has yellowish to orange basidiocarps (Petersen 1967; Brodo et al. 2001). Though this is the first record in Michigan, this species is most likely much more common and should not be added to the list of rare or endangered lichen species in the state (Fryday & Wetmore 2001). The apparent rarity of this taxon is probably due to undercollecting, which may be an artifact of the ephemeral basidiocarps, without which identification is extremely difficult to impossible.

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A NEW LOCATION FOR THE BOREAL SPECIES *PINGUICULA VULGARIS* L. (LENTIBULARIACEAE) IN WISCONSIN

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Butterwort (*Pinguicula vulgaris* L.) is a member of the bladderwort family (Lentibulariaceae). It is a carnivorous, boreal species with a circumpolar distribution. In North America, this plant reaches the southern extent of its range in the northern United States (Voss 1996). The habitat of butterwort is described as "wet rocks and shores, and farther north also in bogs and wet meadows" (Gleason and Cronquist 1991).

On Lake Superior, butterwort has been observed on the rock outcroppings that abound around much of the lake. However, on the south shore of Lake Superior in Wisconsin, there appears to be little suitable habitat for the plant. Until recently, the plant had only been observed on Devils, Ironwood, Otter, and Outer Islands in the Apostle Islands group of Ashland County (Tans 1987, Judziewicz 1993). In the islands, the plants were growing on the steep sandstone cliffs and ledges found on the rugged shorelines of these islands. Population trend studies of Judziewicz and Nekola (2000) found that the larger populations on Devils and Outer Islands tend to be stable as they grow in the seepage joints of the sandstone and are continually kept moist, while the smaller populations on Ironwood and Otter Islands grow in moss mats on fallen sandstone slabs affected by wave splash and as a result are susceptible to decline in dry, calm seasons.

Searches to locate butterwort by Judziewicz in the later part of the 1990s (Judziewicz personal communication) and by Anderson in 2002 and 2003 failed to locate any plants in the sandstone cliffs of the Apostle Island National Lakeshore on the "mainland" of Bayfield County. In late July of 2005 butterwort was finally verified in Wisconsin outside of the Apostle Islands on the southwest shore of Lake Superior when a small population consisting of approximately ten plants was observed among breakwater rocks in the city of Superior. The plants were growing on a thin moss mat that was situated on a small, narrow rock ledge in a crevice among the large boulders used for a breakwater. There were no other vascular plants growing from the moss at the time of the observation. One rosette contained a dried scape from earlier in the year. The greatest mystery of this population is its origin. The closest known populations of the plant are located over 30 km away, along the north shore of Lake Superior in Minnesota.

This find would indicate that the seeds of this plant are capable of traveling great distances through Lake Superior (Judziewicz, personal communication).

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NEW RECORDS FOR *RUELLIA HUMILIS* NUTTALL (ACANTHACEAE) IN WISCONSIN

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The genus *Ruellia* Linnaeus is represented by four species in northeastern U.S. and adjacent Canada (Gleason and Cronquist 1991). Of these, *Ruellia humilis* Nuttall is reported to occur in 25 states in the U.S. The plant is listed on state threatened (T) and endangered (E) species lists in Maryland (E), Michigan (T), North Carolina (T) and Pennsylvania (E). In Wisconsin *R. humilis* is endangered (WDNR, 2005), known from six counties in the two southernmost-tiers of the state (Crawford, Dane, Grant, Portage, Rock, and Walworth) (Wisflora, 2005). Two recent collections of *R. humilis* in Outagamie and Winnebago counties have extended the known range distribution to northeastern Wisconsin.

Ruellia humilis is a perennial forb that goes by numerous common names: fringe-leaf ruellia, hairy ruellia, hairy wild petunia, and wild petunia. Two varieties of *R. humilis* are recognized: var. *calvescens* Fern. of the Appalachian region and var. *humilis* (subject of this report), which is the common and widespread variety with densely hairy internodes, calyx lobes, and leaf veins and margins.

Ruellia humilis var. *humilis* inhabits prairies and dry upland woods, ranging from Pennsylvania to northern Indiana, southeastern Minnesota, Nebraska, south to western North Carolina, Alabama, and Texas (Gleason & Cronquist, 1991). In Wisconsin *R. humilis* is quite rare. It flowers near the end of June to mid-September and fruits from the end of July to September. The plant occurs on dry and dry-mesic prairies, but has been documented more often on disturbed grasslands within railroad right-of-ways, river terraces, and bluffs. Although not a usual occurrence, *R. humilis* was collected from a weedy ditch as an escape in Middleton, Dane County, in 1995 (Cochrane and Iltis 2000). With seed readily available by commercial plant nurseries, *R. humilis* is occasionally propagated during native restoration efforts and in prairie flower gardens. The two records reported here are most unlikely to be escapes from cultivation.

The first Wisconsin record of *Ruellia humilis* is without a specific date but it was collected on or between 1849 and 1862 (Cochrane and Iltis 2000). The next earliest specimen was recorded from Rock County in 1875, while the remainder of dated vouchers are specimens collected in 1921, 1931, 1940, 1987, 1990, 1992, 1993, 1997, and 1998 (Wisflora, 2005).

On 12 July 2003, *Ruellia humilis* (OSH, accession number 106308) was collected from Outagamie County along a roadside ditch off State Highway 55 near Kaukauna. According to the specimen label, the plant was in a "tall grass prairie . . . the collector supposes the plant is native there."

Two years later on 30 August 2005, *R. humilis* was documented in Winnebago County. Like the specimen in Outagamie County, the Winnebago County voucher (OSH accession number 112304) was collected on a prairie remnant within the right-of-way of U.S. 45 (state route 110 on maps more than 2 years old). According to the voucher label, the dry-mesic remnant occurs on top of a limestone (dolomite) outcrop that "is perched above the ditch, such that mowing machines and snowplows cannot reach it."

Associates of *Ruellia humilis* at the Winnebago County site include: *Andropogon gerardii, Asclepias verticillata, Aster ericoides, A. oolentangiensis, Bouteloua curtipendula, Dalea purpureum, Euphorbia corollata, Geum triflorum, Helianthus grosseserratus, H. occidentalis, Isanthus brachiatus, Liatris aspera, Monarda fistulosa, Panicum virgatum, Ratibida pinnata, Rhus glabra, Rosa blanda, Schizachyrium scoparium, Silphium integrifolium* (Winnebago County record), *S. laciniatum, S. terebinthinaceum, Solidago rigida* and *Verbena simplex*, this last species a state Special Concern species (WDNR, 2005).

One noteworthy species among the associates of *Ruellia humilis* is *Coreopsis tripteris,* a new record for Wisconsin that was first collected in 2004 (Wisflora, 2005; Eddy 2005). Since this remnant is situated within the highway right-of-way, the creation of a GIS layer that documents *R. humilis* and associates can assist local and state highway and planning departments to easily locate and then protect this native plant refugium, as well as other roadside remnants, during the planning phase of future highway projects.

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DESMANTHUS ILLINOENSIS (MIMOSACEAE) IN WISCONSIN

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Desmanthus illinoensis (Michaux) MacMillan ex B. L. Robinson & Fernald (Mimosaceae) is a warm season herbaceous/suffruticose perennial that is native throughout much of central and southeastern United States. Common names include "prairie mimosa" and "Illinois or prairie bundleflower." "Bundleflower" is a translation of the Greek roots of the generic name, and has the earmarks of a contrived "common name."

Desmanthus illinoensis flowers in long peduncled axillary heads from May through September. While the white to greenish-white flowers are not particularly showy, the flat, curved seedpods form a cluster about one inch in diameter, usually attracting the notice of collectors (Figure 1). The leaves, which are bipinnate and nearly sessile, fold in strong sunlight or when handled. The plant is taprooted with single or clustered stems to one(+) meter in height.

The USDA plants database reports *D. illinoensis* for 29 states. The species is known from North and South Dakota, Minnesota, and Iowa; thus, it clearly is capable of flowering and fruiting far north of its core range, which is roughly Illinois to Nebraska, south to the Rio Grande and the Gulf of Mexico. It also occurs in the western U.S. in Colorado, New Mexico, Utah, and Nevada. In Minnesota, *D. illinoensis* is listed as a state "special concern" species (Minnesota DNR, 1996), while in North Dakota it is a "threatened species" (USGS, n.d.).

With the increasing popularity of prairie restorations and land reclamations, it appears likely that the species will spread, although it recovers poorly from grassfires (Hilty, n.d.). Its seeds are widely available commercially, for example, at Native American Seed (www.nas.com), where seeds are offered at $12 per pound. Owing to its high protein content, *D. illinoensis* is planted in pastures to feed cattle and enrich soil via nitrogen fixation. Although the plant is regarded as an important range indicator species, *D. illinoensis* favors disturbances and under suitable conditions can become weedy, being reported as "invasive" in certain parts of its range (Southern Weed Science Society, 1998).

In 1983 the USDA Natural Resources Conservation Service and its cooperators made available a cultivar, allegedly *D. illinoensis,* named 'Sabine' that originated near Crystal Beach, Texas (USDA, 2004). The plant "is widely adapted and is found growing on most range sites. 'Sabine' is useful in range and pasture mixes, for wildlife food and shelter, beautification, and in reclamation plantings. 'Sabine' has potential for erosion control through stimulated growth of grass

Figure 1. *Desmanthus illinoensis* in fruit, near Burlington, Des Moines County, Iowa, August, 1979; photo courtesy of Thomas G. Lammers.

species by nitrogen fixation" (USDA, 2004). Moreover, *D. illinoensis* has been evaluated by the Land Institute of Salina, Kansas, as an edible legume for growing with perennial grains in a non-tillage permaculture system (Kulakow et al., 1990).

The species is not ascribed to Wisconsin by Fassett (1939), Luckow (1993), Isely (1998), nor by Wetter et al. (2001). Previously, the sole record for Wisconsin was a sterile specimen in WIS collected in 1968 from a flowerbed that was once the site of an old barn in Ridgeville Township, Monroe County. Presumably, the voucher specimen is from an adventive introduction. To this may now be added a new record from northeastern Wisconsin:

> "Wisconsin. Winnebago County. An isolated plant, no others to be found, in a 17-acre artificial prairie planting on the McDermott and Harrison property, north side of Lone Elm Road, section 32, T17N, R16E. The land was plowed and disked and seeded to an array of native prairie plants in 2001. The land had previously been hayfield and cornfield. The seed of this plant may well have been present as a contaminant in one of the purchased seed lots. Colleen McDermott, 9 September 2005, accession no. 112,295, OSH."

The McDermott specimen is abundantly in fruit, the legumes plump with apparently viable seed. It appears the species is self-compatible, as one would expect in a colonizing species. Luckow (1993) reports a broad ecological amplitude for *D. illinoensis*, including along railroad tracks and other such ruderal sites. Since the plant thrives in a variety of soil types, is drought resistant, and is able to survive harsh winters (hardiness zone 4), coupled with the fact that *D. illinoensis* is readily available commercially, more Wisconsin records for the plant can be anticipated.

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SUGGESTIONS FOR CONTRIBUTORS

1. Create text in 12-point Times-Roman. Please do *not* introduce font changes within the body of the text. Tab at beginning of paragraphs. Please do not use "First line indent," or any other such feature on your word-processing software. Include your e-mail address as a separate line, and telephone number(s) as well if you care to.

2. Create tables as typist's tables; i.e., with tabs. If you use the "Tables" software feature, then convert it to a tab-delimited format before submitting it. Each table is to be submitted as a separate file.

3. Spreadsheets are unacceptable; the typesetter cannot manipulate them. Convert them to tab-delimited tables.

4. Send each figure as a separate file, in a high-resolution format—jpg or tif. The typesetter cannot deal with Power-Point files. Figures like bar graphs that gain their meaning with color won't work—use coarse-grained cross-hatching, etc. Do not include the legend for the figure within the figure. Create figure legends as a separate text file, and the typesetter will insert them as appropriate.

5. Do not assemble the paper. The typesetter will insert your figures and tables as near to their first reference as possible.

6. Eschew abbreviations, particularly in "Literature Cited." Separate author's initials with a space; put a space after the colon when you're citing volume number: and page numbers.

7. Entries in "Literature Cited" are to be typed as hanging indents—simple in WordPerfect, more complex but doable in Word.

8. Italicize scientific names—no underlining.

9. Shorter papers may be submitted as e-mail attachments. You may mail CDs, standard 3.5" diskettes, and Zip diskettes up to 750 megabytes.

10. The editor appreciates "Suggested Reviewers," with e-mail addresses.

CONTENTS

On the cover: *A typical Wisconsin tension-zone swamp woodland, photographed on 25 January 2005 by Bettie R. Harriman. This woods at 5188 Bittersweet Lane, Oshkosh Township, Winnebago County, was preserved by the original settler and descendents as a site for cutting fence posts, firewood, and the like, because it was too low and wet for cultivation. It is a perched wetland on a mini-divide between Lake Winnebago (two miles to the east) and Lake Butte des Morts (three miles to the west). The dominant green ash is dying of a fungal disease; the American elms are mostly gone; the most abundant tree is swamp white oak, which does reproduce despite the presence of a herd of 6–8 Virginia whitetail deer who browse the area almost daily—it is not unusual to see a doe in the spring with triplets trailing behind.*